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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1946

Part I

<u>Work Conducted by State Agencies, Entomological Branch, Canadian Department of Agriculture and Commonwealth of Australia</u>

<u>Not for Publication</u>

This pool of information on the results of codling moth research for the season of 1946 is the fourteenth of a series of similar summaries prepared by the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture, at the request of the Committee on the Codling Moth of the American Association of Economic Entomologists. These data are assembled for the confidential information of workers who are interested in the codling moth problem. The material is not for publication and is therefore not available for quotation or other use without specific permission from the agency which has furnished it.

Because of the general interest in pest control problems arising from the use of DDT for codling moth control in apple orchards and their close relationship to the codling moth spray program, information is included on such problems in this pool of information. The more important such problem pests at the moment include orchard mites, red-banded leaf roller and the woolly apple aphid.

CALIFORNIA

A. D. Borden, University of California, Berkeley.

1. Seasonal conditions and status of infestations:

A cool spring followed by low temperatures in late May and June lessened the attack of the first brood of moth and normal summer temperatures in July and August permitted a heavy second brood attack. Arsenical sprayed orchards showed a high percentage of late entries at harvest even after six spray applications. Orchards sprayed with two or three applications of DDT in the first brood period had no worm problems.

2. DDT

Two programs were followed by the growers using DDT for the first time this season:

	Program A	Program B
Calyx	4 pounds Standard Lead Arsenate	2 pounds 50% wettable DDT
1st Cover	2 pounds 50% wettable DDT	2 pounds 50% wettable DDT
2nd Cover	1 pound 50% wettable DDT	1 pound 50% wettable DDT

Two late covers: 3 pounds lead arsenate plus oil or DN-111.

Excellent codling moth control was obtained under both programs and mite injury was satisfactory when the late sprays were properly timed with mite infestations. Though only a dry spreader or deposit builder was recommended for use with DDT, several growers using one quart of a light medium oil emulsion as a spreader had severe foliage injury on pears and a fruit drop on apples.

Following three years of field experimental work with DDT, a general recommendation has been made for its use on apples and pears for codling moth control in the 1947 season.

3. Analysis of fruit from orchards receiving three and four applications of DDT.

No fruit going above the tolerance at harvest.

Investigations being conducted by this Experiment Station have resulted in a method by which DDT and lead arsenate spray residues may be removed by the simple addition of certain types of detergents to the acid wash providing no oil has been used in combination with DDT in the spray mixture. When DDT is used in the earliest sprays of the first brood and not in the second brood sprays no noticeable increase in mite infestations on pears was observed. Woolly apple aphid on apple showed marked increase even after a single DDT spray in the spring.

4. Other materials tested in the field for codling moth control.

1068: On Bartlett pears following a lead arsenate calyx spray. Dosage of 1, 2 and 4 pounds per 100 gallons in three cover sprays. Results very poor.

666: On Bartlett pears following a lead arsenate spray. Four pounds (10% gamma) per 100 gallons, three cover sprays. No control.

Genicide A: On late pears following two lead arsenate sprays. Two pounds per 100 gallons in two late covers. Excellent codling moth control and good mite control.

5. Field experiments with miticides on Bartlett pears:

Single plot with eight replicates, three applications spaced 17 days apart for control of two spotted and European red mite.

	Pounds per 100 Gallons
Flavan	4
DN-111	3/4
Xanthone	1
4% Rotenone-Kerosene	4
1068	2
Azobenzene K-1875	1.5
K-1875	1/2, 1, 2

Of these materials only DN-111 gave satisfactory control of both species. A commercial xanthone formulation (containing an excess of wetting agent) was second in the results obtained. None of the other materials proved satisfactory.

1947 Spray Recommendations for the control of Codling Moth with DDT on Apples and Pears in Northern California

During the past three seasons of investigational work with DDT (dichloro-diphenyl-trichloroethane) for the control of codling moth on apples and pears the results have been excellent. It has proven so much more efficient than lead arsenate that its use during the coming season is generally recommended on apples and pears. There has been no apparent injury to fruit or foliage except when used in combinations with oil emulsions or when the DDT was dissolved in oil. The outstanding advantage in the use of DDT is that good codling moth control with this material has been obtained with the use of not over three applications of DDT where from five to seven applications of lead arsenate have been required. As few as two thorough applications of DDT in the early season (calyx and first cover sprays) have practically stopped the flight and eliminated the damage of the first brood of codling moth. A third application at a reduced dosage has stopped second brood attacks on late varieties of fruit. This reduction in materials and in the cost of applying sprays combined with the more efficient control of codling moth will mean much to the apple and pear growers in California.

Timing of DDT applications. It has been found that it is not necessary to attempt to fill the calyx cups with DDT as has been the practice with lead arsenate. Instead of starting to spray with DDT when 50 to 75 percent of the petals are off (as has been the practice for years with lead arsenate) the first application should not be made until 90 percent or practically all of the petals have fallen. There has been some evidence that DDT sprayed in the blossoms has prevented the natural setting of fruit.

The second application should be started 15 to 17 days after the beginning of the first spray. The third application, if required on early harvested varieties, should be applied at least three weeks before harvest. On late varieties of pears and apples this application should be made in late June or early in July at the first appearance of the second brood of moths.

Materials and dosages recommended. The fifty percent wettable DDT powder, as used during the past season, is apparently the safest and most economical formulation to use on pears and apples. The addition of a small amount of a powdered spreader such as 4 ounces of Multifilm or 8 ounces of DDT depositor plus from 1 pint to 1 quart of kerosene will increase the deposit of DDT on the fruit. No spreader containing spray oil or any type of spray oil emulsion should be used with DDT as leaf injury and even defoliation may occur. The addition of lead arsenate to the following DDT spray formulae is not necessary but if for any reason it is desired to use lead arsenate either in a split program or in combination with DDT the 1946 spray program may be followed. Small amounts of so-called soluble copper compounds, Bordeaux mixture, or

sulfur may be added to the early DDT sprays for the control of scab, mildew, and the prevention of fireblight if necessary.

In the first two applications (delayed calyx and first cover spray) the following dosages are recommended:

50 percent DDT wettable powder	1 1/2 to 2 1/ pounds.
Dry spreader or deposit builder	4 to 8 ounces
Kerosene	1 pint to 1 quart
Water	100 gallons

In the late cover spray:

50 percent DDT wettable powder	1 to 1 1/2 1/ pounds
Dry spreader or deposit builder	4 to 8 ounces
Water	100 gallons

In this late spray the addition of a miticide such as DN-111 or xanthone to control the brown mite, two-spotted mite and European red mite may be added to the DDT formula. Dosages of these miticides should follow the manufacturer's recommendations. Kerosene or oil emulsions should not be used with DN-111. Kerosene (up to 1 quart per 100 gallons of spray) may be added to the DDT-xanthone combination but no oil emulsions should be used with xanthone. Oil emulsions for the control of mites should not be combined with DDT or used within three weeks of the last DDT application.

On apples the woolly apple aphid may become a serious pest following the use of DDT. Timely applications of an aphicide, such as nicotine or some of the new materials may be required.

DDT spray residue at harvest. The past seasons investigations have shown that three or even four applications of DDT at the dosages recommended above when properly timed did not leave a spray residue at harvest above the Federal and State tolerances of 7 parts per million. Furthermore, through the research of this Division, a method is now available for the removal of DDT on harvested fruit which is both practical and effective.

The acid wash, as used for the removal of lead arsenate, is not effective in the removal of DDT deposits. The addition of certain types of oil soluble and water soluble detergents to the regular acid wash will remove both the DDT and lead arsenate spray deposits. The specific recommendations for the removal of DDT spray residues will be given in another publication.

1/ The higher dosages to be used where infestations are serious.

CALIFORNIA (Continued)

M. M. Barnes, R. S. Trueman,[1] and G. L. Heitsman,[2] University of California, Citrus Experiment Station, Riverside.

Scope of investigations. In the southern portion of the State, studies were continued or initiated relative to establishing on:

A. Pears: (1) An effective seasonal schedule for codling moth using DDT, dichloro diphenyl trichloroethane; (2) the effectiveness of new compounds as compared with DDT; (3) the effectiveness of various materials in the control of Pacific mite, Tetranychus pacificus McG.; (4) the efficiency of a semi-automatic sprayer as compared with standard equipment in a seasonal program with DDT.

B. Apples: (1) The effectiveness of several of the newer insecticides as compared with DDT; (2) the toxicity of several 50 percent DDT spray concentrates prepared with varied types of extenders; (3) the effectiveness of various materials for control of woolly apple aphid, Eriosoma lanigerum (Hausm.)

General remarks. Seasonal conditions were favorable during 1946 for codling moth development in southern California orchards. Losses on trees sprayed with experimental materials which proved ineffective ranged up to 70 percent entered fruits. Orchards receiving inadequate spray schedules based on lead arsenate had an estimated 10 to 60 percent cull fruits. Where at least four well-timed sprays containing one-half pound of DDT per 100 gallons were thoroughly applied, excellent codling moth control on apples and pears was generally attained in this region. In this connection it is pointed out that weathering by rainfall during the critical part of the season ranges from practically none in the desert sections (Antelope Valley) to relatively light in mountain orchards (Oak Glen, Julian).

All residue analyses herein reported were carried out by Mr. F. A. Gunther and his assistants.

Dosages given in the text refer to amount of materials per 100 gallons.

A Bantam Mikro-Pulverizer hammer mill was used in processing spray concentrates. Herringbone slot screens were used in this connection.

1/ Formerly Principal Laboratory Assistant.

2/ Formerly Senior Laboratory Assistant.

Bartlett Pears, Antelope Valley, Codling Moth.

This trial was replicated six times using single tree plots. Data represent all fruits and are based on counts on all drops and a random sample of 500 harvested fruits. An estimate was made of the remaining number of harvest fruits based on the number of fruits required to fill two boxes, taking an equal number of fruits from each harvest box. Schedules, treatments, and data are presented in Table I.

With reference to schedules 1-4, consisting of no calyx spray, either 1 or 2 calyx sprays followed by 4 covers with 1/2 pound DDT, and 1 calyx followed by 4 covers with 1 pound DDT, results indicate that calyx entries were not a serious factor with any of these schedules under the conditions of this trial.

Referring to treatments 2, 5 and 6, a wettable powder containing 75 percent DDT and a kerosene solution of DDT, when applied at equal (1/2 pound) DDT dosage, gave results equivalent to a 50 percent wettable powder. A comparison among treatments 2, 7 and 8 indicates that the methoxy analogue of DDT, dimethoxy diphenyl trichloroethane, and DDD (dichloro diphenyl dichloroethane) at one pound of toxicant gave equal control performance. Heavy preharvest fruit drop was recorded (see Table I) on trees sprayed with the methoxy analogue of DDT (treatment 7). Hcc., hexachlorocyclohexane, at 1/2 pound gamma isomer was inferior to DDT at 1/2 pound (99-1). For further data on these materials in a heavier codling moth infestation, see results on Rome Beauty apples.

Results of analyses for surface residues of DDT show that there were well below the tolerance of 7 parts per million, wet weight, for all sampled schedules (Table I) during the past season.

No acaricide was included in application of these materials and trees of all treatments were severely defoliated by Pacific mite.

Bartlett Pears, Antelope Valley, Pacific Mite.

DDT was given widespread commercial use in seasonal codling moth programs on pears in southern California orchards. The occurrence of build-up of Pacific mite was virtually universal following such programs and ranged in severity from light (Julian area) to very severe (Antelope Valley). In the latter area, two pre-harvest applications (usually the last two cover sprays) of DN-111 at 3/4 pound were fairly successful in holding mite infestations in check. In addition, a post-harvest application was generally required to reduce subsequent injury.

Concurrent but less injurious infestations of clover mite, Bryobia praetiosa Koch, developed in connection with seasonal DDT programs.

Where acaricide programs were inadequate, defoliation due to Pacific mite ranged from 30 to 50 percent by harvest and was followed by blossoming and new growth in many instances.

Four sets of acaricide formulations were applied for Pacific mite, usually in connection with the codling moth cover spray due on the date of application. Data are presented in Tables II to V. Data from Tables II, IV and V indicate the amount of defoliation and are based on the number of leaves falling into five field boxes (1.85 square feet each) placed under each of 6 to 8 single tree replicates for the period July 10 to August 1. Data from Table III represent average increase in mite injury based on numerical injury ratings assigned by visual observation to each of seven single tree replicates before and three weeks after treatment.

The following statements summarize information from these trials. From Table II the superiority of DN-111 at 3/4 pound to Flavan Miticide Composition at 4 pounds, DDT at 2 1/2 pounds, and DN-111 at 1/2 pound is indicated. The promising results from the use of tartar emetic led to the trial in Table III. This series was applied in an established mite infestation, whereas data in Table II are from a trial where the population consisted largely of overwintering mites. Tartar emetic and potassium antimonyl citrate appeared to have considerable toxicity to free living stages but did not materially affect development of the infestation due to subsequent egg hatch.

Table IV presents data indicating promise for Genicide and experimental materials containing dichloro diphenoxy methane (K-1875) and the dicyclohexylamine salt of dinitro-o-secondary butyl phenol (DN-211) in comparison with DN-111. Di-2-ethyl hexylphthalate (No. 899) did not provide adequate control in this trial.

In connection with Table V, treatments 2 and 4 caused a serious amount of necrotic spotting on pear foliage. This may be due to the Velsicol AR-60 or to K-1875 in kerosene solution. Elsewhere, a seasonal program of kerosene-DDT gave no visible injury, nor did K-1875 as a wettable powder. Marked differences in mite control between treatments 2 and 4 (19:1) may possibly be due to an incompatibility. Elsewhere, DDT applied in kerosene solution resulted in no greater increase in mite population than where DDT was used as a wettable powder. Dithane was included since it had been reported in commercial use against Pacific mite. It gave inferior control in this trial. Results indicate that further trials with experimental material C-420 and K-1875 are in order. For the latter, solvent formulations and an increase in dosage for the wettable powder are indicated.

Standard vs. semi-automatic spraying equipment. A seasonal trial of the F. E. Myers and Bro. Co.'s Silveraire, air-blast type sprayer was conducted on mature Bartlett pear trees in the Antelope Valley. All applications were made by the cooperating grower. A late calyx (April 20) and four covers (May 24, June 18, July 11, July 24) of 1/2 pound DDT were applied to a block of 1 1/4 acres between larger blocks carried with an identical program by a standard spray rig equipped with one tower and one ground lead. The last two covers were applied from one side only. DN-111 at 3/4 pound was added to two sprays (May 24, June 18). Based on counts of dropped fruits and a sample of 500 harvest fruits from each of five trees in blocks variously sprayed, an average of 99.6 percent clean fruits was recorded for each type of equipment. With a 2 calyx and 4 cover lead arsenate program, the grower had experienced a 52.4 percent loss due to codling moth in 1945. Control of Pacific mite was inferior in the tops of trees sprayed with the Silveraire sprayer, as compared with the standard equipment. Some fruits approaching maturity were blown off in the last application by the Silveraire sprayer.

Rome Beauty Apples, Oak Glen, Codling Moth.

This trial was replicated nine times using single tree plots. Data represent injury to the total crop. All dropped fruits or a sample of 600, where the number was excessive, were examined and the remainder counted. A sample of 600 harvest fruits was examined. The remaining number of harvest fruits was estimated from the number required to fill two bushel boxes, using an equal number of apples from each harvest box.

All materials were prepared from technical grades of the toxicants. A comparison was made among four formulations of DDT using a 1/4 pound dosage, a wettable DDT powder at 1/4, 1/2 and 3/4 pound dosage, and among DDD, Hcc, the methoxy analogue of DDT, Velsicol 1068, and DDT at 1/2 pound active ingredient per 100 gallons. Hcc was used at the rate of 1/2 pound of the gamma isomer. In addition, a comparison was made between a solvent formulation and a wettable powder formulation of Velsicol 1068 at 1/2 pound.

No calyx and four cover sprays (May 31, June 21, July 16 and August 13) were applied.

Results are presented in Table VI. The following discussion refers to the data on percent entered unless otherwise stated. DDT when applied in kerosene solution at 1/4 pound was equal to 1/2 pound as a wettable powder, was better than 1/4 pound as a wettable powder (99:1), was better than 1/4 pound in Velsicol AR-60 (approaching 19:1), and was better than unprocessed technical DDT (99:1). Velsicol 1068 failed to control adequately and was inferior to all other materials (greater than 99:1). The data indicate preference for the wettable powder formulation of Velsicol 1068 over the kerosene solution (19:1). In comparable formulation and dosage, DDD, the methoxy analogue of DDT, and Hcc were not

significantly inferior to DDT at the 19:1 level in preventing all types of injuries. Hcc as applied seasonally affected the flavor of the fruits adversely, as has previously been reported by L. F. Steiner of the U.S.D.A. laboratory at Vincennes, Indiana. In this connection, see discussion below on woolly apple aphid.

No visible spray injury resulted from any of the formulations. No apparent control was exerted over clover mite by any of the materials. This species built up on all plots to cause moderate yellowing of foliage by harvest, October 3. DN-111 at 3/4 to 1 pound applied about June 15 effected good control of this species on apples in other orchards.

Samples taken at harvest at random and in triplicate for analyses of DDT surface residues from all DDT schedules gave values below 2 parts per million which were not distinctive of treatment.

Delicious Apples, Oak Glen, Codling Moth.

DDT (technical grade, du Pont) was hammer milled four times with Attapulgus clay, Celite 209, Silene EF, Marter White 325, Sericite, Filtrol X-415, and Dilroc at 50 percent of DDT and extender. The resultant products were carried into the field and applied in four cover sprays at 1/4 pound DDT to single tree replicates in each of nine blocks. Also applied at the same rate of DDT were Gesarol AK 50, and DDT-Celite 209 in ratios of 25-75 and 75-25. The entire block had received a calyx spray of 1/2 pound DDT.

Data from all drop and a sample of 300 harvested fruits figured above 99 percent clean fruits for all treatments. The absence of any extender effect in this trial may be real or due to the fact that the effect was of such a low order of magnitude as not to appear with the dosage used under the experimental conditions encountered.

Delicious Apples, Oak Glen, Woolly Apple Aphid.

Populations of woolly apple aphid, *Eriosoma lanigerum* (Hausm.) have built up materially in some southern California orchards following seasonal use of DDT. One Delicious orchard under observation which received a calyx of 1/2 pound and 4 covers of 1/4 pound DDT plus 3/4 pound DN-111 in the third cover had an average of 82 percent of terminals bearing aphid colonies by the end of the season. This count was based on examination of 30 terminals at random on each of 38 trees prior to making fall dormant trials against the species. Adjacent parts of the same orchard receiving a similar program, but with 1/2 pound DDT in all sprays, had 53 percent of terminals infested, based on similar counts. In San Diego County, Starking trees receiving three applications of one

pound DDT bore aphid colonies on virtually all terminals at the conclusion of the 1946 season. In contrast, few aphid colonies were found on adjacent, similarly sprayed Rome Beauty trees.

A series of materials was applied to two single tree plots of trees infested with woolly apple aphid on June 29. At this time the typical, heavy, filamentous wax coating was present. This trial was set up as a preliminary screening of several materials and in order to obtain additional information on the concentration of Hcc required. The latter was reported as effective against woolly apple aphid by Dr. G. E. Carman of this Station in 1945. Materials tried and observations on control are given in Table VII.

Of these materials, the hexaethyl tetraphosphate treatment provided a high degree of control and was equal to the nicotine sulfate standard. This treatment gave good kill of a light infestation of clover mite also present. At concentrations of 0.3 pound gamma isomer and above, Hcc practically eliminated aphid colonies. Treatment 4 on June 29 (a higher concentration than required) adversely affected the flavor of fruits harvested September 27. Lower concentrations applied on June 29 had no detectable effect on the flavor of the fruits.

On July 30, Hcc was applied to 20 infested trees at the rate of 0.25 pounds gamma isomer (3 1/3 pounds Gamex W25, plus 1/4 pint Triton B-1956). This treatment killed over 95 per cent of aphid colonies and adversely affected the flavor of fruit harvested September 27.

It would be desirable to make application for woolly apple aphid in connection with codling moth sprays. The question of whether Hcc may effectively be used in connection with early cover sprays at the 1/4 pound gamma isomer dosage without hazard to fruit flavor will receive further attention.

Fall dormant application (December 13) of 0.24 pound gamma isomer 1/ gave

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1/ Chemhex 60W (Chemurgic Corp.) at 4 lbs., plus 1/4 pt. Triton B-1956.

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a reduction of 85.7 per cent in number of terminals bearing aphid colonies. 0.12 pound gamma isomer gave a reduction of 63.3 per cent. These figures are based on counts made of 30 terminals on 12 trees before and 18 days after treatment. Check trees experienced a reduction of 27.0 per cent during this period.

Woolly apple aphids are still overwintering in large numbers on terminals in this area (December 31) and do not have the waxy coating present.

Table I. Codling Moth, Bartlett Pears, Antelope Valley, 1946

Materials	Amounts Per 100 gals.	Number Calyx Sprays 1/	Number Covers 2/	Injuries per 100 fruits: Calyx Entries	All Entries	All injuries 3/	ppm DDT 4/	Per cent Drop 5/
1. DDT-Celite 209(50-50)6/	1 lb.	0	4	.8	2.3	3.7	--	18
2. DDT-Celite 209(50-50)	1 lb.	1	4	.6	1.6	3.0	0.9	20
3. DDT-Celite 209(50-50)	1 lb.	2	4	.2	.9	1.6	--	18
4. DDT-Celite 209(50-50)	2 lbs.	1	4	.2	.7	1.9	1.7	17
5. DDT-Celite 209-Triton X-120 (75-24.3-.7)7/	2/3 lb.	1	4	.6	2.2	3.3	--	19
6. 4% DDT in Kerosene(wt./vol.) Blood albumen spreader	1-1/2 gal. 2 oz.	1	4	.3	1.4	3.6	0.3	20
7. Orthotox8/	4 lbs.	1	4	.9	3.5	4.9	--	42
8. Rhothane WP509/	2 lbs.	1	4	.9	3.8	5.5	--	17
9. Hcc-Celite 209(50-50)10/	10 lbs.	1	4	3.0	9.7	11.8	--	22
10. Gesarol AK5011/	1 lb.	1	4	.2	1.5	2.2	0.9	17
Least significant difference				.05		4.8		
				.01		6.4		

1/ Treatment 3, April 16 and 30; others April 23.
2/ May 17, June 6, July 6, July 22.
3/ Includes stings and all entries.
4/ Average of 3 random samples taken August 22; harvest September 9.
5/ Due to causes other than codling moth injury.
6/ Milled through hammer mill with the following screen sequence: no screen, 1/16, 1/16, .035. Technical grade DDT - duPont (E. I. duPont de Nemours & Co.). Celite 209 - Johns-Manville Corp.
7/ Milled as above. Triton X-120, Rohm & Haas, Co., 40 per cent Triton X-100 (polyethylene glycol monoisooctyl phenyl ether) on magnesium carbonate.
8/ California Spray Chemical Corp. 25 per cent technical dimethoxydiphenyl trichloroethane.
9/ Rohm & Haas Co. 50 per cent technical dichloro diphenyl dichloroethane.
10/ Hexachlorocyclohexane, E.I. duPont de Nemours & Co., technical grade, 10 per cent gamma isomer. Mixture milled as in note 6/.
11/ A wettable powder containing 50 per cent technical DDT. Geigy Co.

Table II. Pacific Mite, Bartlett Pears, Antelope Valley, 1946

Materials 1/	Per 100 gal.		Average number leaves per sq. ft. July 10 to August 1
1. DN-111 2/	3/4 lb.		13
Colloidal Z1 3/	5 oz.		
2. Tartar emetic 4/	2 lbs.		20
3. Loro 5/	1 pt.		25
4. Mitox 6/	2 qts.		28
5. Flavan Miticide Composition 7/	4 lbs.		34
6. DN-111	1/2 lb.		36
Colloidal Z1	5 oz.		
7. Gesarol AK50	5 lbs.		43
	Least significant difference	.05	16
		.01	21

1/ Applied June 5, 8 replicates. All treatments except No. 7 are in addition to 1 lb. Gesarol AK50.
2/ Dow Chemical Co. Contains not less than 20 per cent of dicyclohexylamine salt of dinitro-o-cyclohexylphenol.
3/ A spray supplement supplied by Colloidal Products Corp.
4/ Tartox, Stauffer Chemical Co., 99 per cent potassium antimonyl tartrate.
5/ E.I. duPont de Nemours & Co. Aliphatic thiocyanates expressed as lauryl thiocyanate not less than 40 per cent, sulfated fatty matter not less than 40 per cent, inert ingredients not more than 20 per cent.
6/ Donahue Manufacturing Co., 92 per cent medium oil, other ingredients not stated but claimed to be active.
7/ E.I. duPont de Nemours & Co. Technical grade hydroxy-pentamethyl flavan 30 per cent.

Table III. Pacific Mite, Bartlett Pears, Antelope Valley, 1946

Materials 1/	Pounds per 100 gals.	Increase in Rating totals 2/ July 15 to August 6
1. Tartar emetic 3/	3/4	7.0
2. Tartar emetic	1-1/2	5.5
3. Tartar emetic	2	4.0
4. Potassium antimonyl citrate 4/	2	1.0
5. DN-111	3/4	0.0
6. Check, no treatment	---	7.5

1/ Applied July 15, 7 replicates.
2/ Based on injury rating system as follows: 0-1, None to slight injury; 1-2, slight to moderate injury; 2-3, moderate to severe injury; and 3-4, severe to very severe injur
3/ Tartox, Stauffer Chem. Co., 99 per cent potassium antimonyl tartrate.
4/ Citrometic, Westwell Chem. Co., 92 per cent potassium antimonyl citrate.

Table IV. Pacific Mite, Bartlett Pears, Antelope Valley, 1946

Materials 1/	Per 100 gals.	Average number leaves per sq. ft. July 10 to August 1
1. DN-111	3/4 lb.	12
Colloidal Z1	5 oz.	
2. DN-211 2/	3/4 lb.	11
Colloidal Z1	5 oz.	
3. K-1875 3/ - Celite 209 (50-50)	1 lb.	15
Colloidal Z1	5 oz.	15
4. Genicide 4/	2 lbs.	15
Kerosene	1 qt.	
Genifilm A 5/	8 oz.	
5. No. 899 6/	2 qts.	26
Least significant difference	.05	6
	.01	8

1/ Applied June 15, 6 replicates, all treatments in addition to 1 lb. Gesarol AK50.
2/ Dow Chemical Co. An experimental acaricide containing 20 per cent dicyclohexylamine salt of dinitro-o-secondary butyl phenol.
3/ Dow Chemical Co. Dichloro diphenoxy methane. Mixture milled through hammermill with the following screen sequence, 1/16, .035, .035.
4/ General Chemical Co. Contains 95 per cent dibenzo gamma pyrone, 4 per cent dibenzo gamma pyrone derivatives, and 1 per cent inert ingredients.
5/ A proprietary spray adjuvant supplied by General Chemical Co. for use with Genicide.
6/ American Cyanamid Co. di-2-ethyl hexylphthalate.

Table V. Pacific Mite, Bartlett Pears, Antelope Valley, 1946

Materials1/	Amounts Per 100 gals.	Average number leaves per sq. ft. July 10 to August 1
1. DN-111	3/4 lbs.	8
Colloidal Z1	5 oz.	
2. K-1875 1 lb.)		
Kerosene 3 gal.)	1-1/2 gal.	13
Velsicol AR 60 3 qts.)		
Blood albumen spreader	2 oz.	
3. C-4202/	3/4 qt.	16
4. K-1875 1 lb.)		
DDT 1 lb.)	1-1/2 gal.	34
Kerosene 3 gal.)		
Velsicol AR 60 3 qts.)		
Blood albumen spreader	2 oz.	
5. K-1875-Celite 209 (50-50)	1 lb.	40
Colloidal Z1	5 oz.	
6. Check, DDT only	--	46
7. Dithane3/	2 qts.	56
Zinc sulfate4/	1 lb.	
Hydrated lime	1/2 lb.	
Least significant difference	.05	20
	.01	27

1/ Applied June 24, 6 replicates, 1 pound Gesarol AK50 added to all but No. 4.
2/ Dow Chemical Co. An experimental formulation.
3/ Rohm & Haas Co. disodium ethylene bisdithiocarbamate hexahydrate 25 per cent.
4/ $ZnSO_4 \cdot 5H_2O$, containing 25 per cent zinc (as metallic zinc).

Table VI. Codling Moth, Rome Beauty Apples, Oak Glen, 1946

	Materials 1/, 2/	Amounts Per 100 gal.	Toxicant lb/100 Gallons	Entries 100	Percent Calyx entered	Total percent entered	Angles 3/ percent entered	Stings 100	Per-cent Stung	All injuries 100	Percent Injured
1	DDT 4/-Celite 209 5/ (50-50)	1-1/2 lb.	3/4	8.5	0.7	7.0	15.36	4.4	4.1	12.9	11.5
2	DDT -Celite 209 (50-50)	1 lb.	1/2	15.6	1.4	12.4	20.63	4.2	3.8	19.8	17.5
3	DDT-Celite 209 (50-50)	1/2 lb.	1/4	28.6	2.8	21.9	27.92	8.2	7.4	36.8	31.4
4	4% DDT in Kerosene (wt./vol.) Blood albumen spreader	3 qt. 1 oz.	1/4	15.0	1.4	11.0	19.39	9.6	8.3	24.6	21.2
5	47.9% DDT in Velsicol AR 60 Blood albumen spreader	1/2 pt. 1 oz.	1/4	24.6	2.4	18.2	25.28	11.8	9.9	36.4	30.5
6	DDT-water-Glycox 1300 6/ (50-49-1)	1/2 lb.	1/4	48.1	4.1	34.1	35.74	8.5	7.5	56.6	40.7
7	Velsicol 1068 7/-Frianite M3x (16-2/3-83-1/3)	3 lb.	1/2	91.1	8.9	60.0	50.75	9.0	7.9	100.1	67.3
8	Velsicol 1068-Kerosene-Triton X-155 8/ (50-49-1)	0.3 qt.	1/2	109.6	8.6	70.6	57.18	9.0	8.1	118.6	77.5
9	Hcc 9/-Celite 209 (75-25)	6-2/3 lb.	1/2 (gamma isomer)	21.7	2.4	15.7	23.32	5.0	4.8	26.7	24.3
10	DDD 10/-Celite 209 (50-50)	1 lb.	1/2	21.6	1.6	16.6	24.02	7.6	6.7	29.2	25.1
11	Methoxy analogue of DDT 11/-Celite 209 (50-50)	1 lb.	1/2	25.2	2.2	19.6	26.31	6.0	5.5	31.2	26.6
	Least significant difference		.05	16.8			6.23			14.5) 12/	
			.01	22.2			8.25			19.3)	

1/ All wettable powders with Celite 209 extender were milled with technical grade of toxicant through screen sequence-no screen, 1/16, 1/16, .035.
2/ Nine single tree replicates. No calyx, 4 covers on May 31, June 21, July 16, August 13.
3/ Angle transformation used for percentage values for analysis of variance.
4/ E. I. duPont de Nemours & Co., technical grade DDT throughout.
5/ Johns-Manville.
6/ Glyco Products Co., Inc.
7/ Velsicol Corp. Technical grade. Impregnated on Frianite M3x from acetone solution.
8/ Rohm & Haas Co.
9/ Technical grade hexachlorocyclohexane containing 10 percent gamma isomer. E. I. duPont de Nemours & Co.
10/ Technical grade dichloro ddphenyl dichloroethane. Rohm & Haas. Co.
11/ Technical grade dimethoxy diphenyl trichloroethane. California Spray Chemical Co.
12/ Analyses for "all injuries" exclusive of treatments 6, 7, and 8.

Table VII. Woolly Apple Aphid, Delicious Apples, Oak Glen, 1946

Materials	Amounts Per 100 gals.[1]	Toxicant Per 100 gals.	Summation[2]
1. Gamex W 25[3]	2/3 lb.	.05 lb. gamma	Poor
2. Gamex W 25	1-1/3 lb.	.10 lb. gamma	Poor
3. Gamex W 25	4 lbs.	.30 lb. gamma	Excellent
4. Gamex W 25	6-2/3 lbs.	.50 lb. gamma	Excellent
5. Vapotone[4]	1 pt.	1/2 pt. HETP	Very good
6. Black Leaf 40 Hydrated Lime	1 pt. 1 lb.		Very good
7. K-1875[5]-Celite-Triton X-120[6] (50-49.3-0.7)	2 lbs.	1 lb. K-1875	No control
8. No. 899[7]	1 qt.	1 qt. No. 899	No control, necrotic spotting and yellowing of young leaves
9. Velsicol 1068[8]-Kerosene-Triton X-155[6] (50-49-1)	0.3 qt.	1/2 lb. 1068	Poor
10. PCH[9]-Kerosene (20-80)	2 qts.	1/10 gal. PCH	No control
11. Ryania, extract ME-1[10]	1 qt.		Poor
12. Loro[11]	1 pt.		Poor
13. Flavan Miticide Composition[12]	4 lbs.	1.2 lbs. flavan compound	No control
14. Triton X-100[6]	0.4 qt.		No control

1/ Plus 4 oz. Triton B-1956[6] except nos. 5, 12, and 14.
2/ No control - less than 10 per cent of colonies killed; poor control - 10 to 30 per cent of colonies killed; very good - over 85 per cent of colonies killed; excellent - over 95 per cent of colonies killed.
3/ Pennsylvania Salt Mfg. Co. Contains 7.5 to 8 per cent gamma isomer of hexachlorocyclohexane.
4/ California Spray Chemical Co. 50 per cent hexaethyl tetraphosphate.
5/ Dow Chemical Co. Prepared by milling through hammer mill secreen sequence, 1/16, 1/16, .035.
6/ Rohm & Haas Co.
7/ American Cyanamid Co. di-2-ethyl hexylphthalate.
8/ Velsicol Corp.
9/ Dodge & Olcott. Piperonyl cyclohexanone.
10/ Merck & Co. Methanol solution, extractive of 2.5 lbs. of Ryania wood per pint.
11/ E.I. duPont de Nemours & Co.
12/ E.I. duPont de Nemours & Co. Thirty per cent technical hydroxy-pentamethyl flavan.

CONNECTICUT

Philip Garman and J. F. Townsend, Connecticut Agricultural Experiment Station, New Haven.

Codling moth populations were generally low in Connecticut during 1946, but DDT was used wherever infestations threatened. Mites increased after August 1 and continued to multiply until harvest or later, contrary to the usual trend. Reports of damage by mites were general over the state. Mite control experiments demonstrated the superiority of DN-111 and xanthone for combining with DDT. (Tables 4, 5), and one non-arsenical schedule combining benzene hexachloride, DDT and DN-111 showed promising results in control of all orchard insects and mites. (Tables 1,2). In these plots, the foliage remained green until frost and the size of the fruit was definitely increased as shown by grading records--probably because of low mite populations, Table 3. Hexaethyl tetraphosphate was not received early enough to be included in any program, but one test with it (at twice recommended strength) gave some burn.

Benzene hexachloride (1 - 2 pounds, 50 percent per 100 gallons) controlled plum curculio about as well as lead arsenate in adjacent plots (Table 2). Control was certainly no better. Furthermore, laboratory cage tests indicate that the active ingredient loses much of its potency for curculio within a week, and concentrations of 1 to 2 pounds actual benzene hexachloride are needed to prevent feeding. In field tests, no objectionable odor remained at harvest after a 9-week interval following the last application.

Small increases in amount of fruit damaged by the red-banded leaf roller were seen this year where DDT was compared with lead arsenate (Table 6). These differences appeared to be significant by analysis. If the damage following DDT increases above the amount seen in 1946, measures will have to be found to take care of it. The small amount experienced this year probably does not warrant it.

Work on the codling moth in 1946 was directed largely toward observations on the effects of the intensified control program sponsored by the Extension Service, special attention being given to orchards that have been studied for several years. Studies on the biology of the codling moth were limited by shortage of stock of the insect. Data on moth emergence from overwintered stock, and on moth flights from bait pail catches were secured for information on seasonal life history in relation to weather, and for immediate practical use in timing the spray program.

With spring temperatures somewhat similar to 1945, conditions were similarly unfavorable for oviposition by the early-emerging moths and the latter part of the first brood moths was delayed even later than in 1945. Severe damage in several orchards might have occurred, as in 1945, but for the sprays timed to combat it. Severe damage did occur in one commercial orchard in which the trees were obviously too overgrown for effective spraying. In infested orchards previously under observation,

infestations were kept at low levels or reduced under improved control practices, and with sprays of either lead arsenate or DDT.

DDT in direct comparison with arsenate of lead proved definitely superior in codling moth control. The presence of "resistant" strains of the insect is suspected in two or three orchards, but it has not yet been demonstrated that control cannot be obtained with arsenate of lead accompanied by good general control practices. The benefits of good general control practices in both orchard and packing shed have been emphasized and experience indicates that such measures are major, rather than minor, factors in codling moth control in Connecticut.

Table 1. European Red Mite Counts, Mount Carmel Farm, 1946.

A--Lead Arsenate-Sulfur 1/				B--DDT, etc. 1/		
Variety	Tree	Adult Females per Leaf		Tree	Adult Females per Leaf	
		Aug. 14	Aug. 22		Aug. 14	Aug. 22
Baldwin	L6	13.4	38.7	L7	3.26	5.0
Baldwin	M6	18.5	59.0	M7	1.92	4.2
Hurlbut	N6	24.4	59.2	N7	2.58	8.2

Note: Leaves on treatment "B" remained green to end of season.

1/ Complete formula and dates of application on following page.

Table 2. Comparison of Curculio Control with Sulfur - Lead Arsenate and Sulfur and DDT - Gammexane - DN-111 Spray Program, Experiment Station Farm, Mount Carmel, 1946.

A--Lead Arsenate 1/				B--DDT, etc. 1/			
Variety	Tree	Apples	Curculio	Tree	Apples	Curculios	Difference
		No.	%		No.	%	
Wealthy	A5	626	44.56	C13	332	18.98	- 25.28
	A8	263	55.51	B13	311	37.62	- 17.89
	A10	122	25.41	A13	751	10.51	- 14.90
Baldwin	L6	5229	3.61	L7	3481	6.94	+ 3.33
	M6	2683	2.98	M7	2965	1.96	- 1.02
Hurlburt	N6	6611	2.78	N7	5117	13.81	+ 11.03
			Mean difference in favor of DDT, etc. (Not significant by statistical analysis)				7.46%

1/ Complete formula and dates of application on following page.

Table 3. Fruit Size Comparisons of the Two Previous Schedules

		PERCENT						
Variety	Tree	Below 2-1/2 Inches	2-1/2 to 3 Inches	Above 3 Inches	Tree	Below 2-1/2 Inches	2-1/2 to 3 Inches	Above 3 Inches
Baldwin	L6	53.53	44.37	2.10	L7	19.17	68.86	11.97
Baldwin	M6	18.49	72.15	9.35	M7	7.52	65.97	26.51

Treatment and Dates - Amounts are for 100 Gallons

A. April 6 — Delayed dormant DN solution (Krenite)
April 24 — Lead arsenate 3 lb., "Mike" sulfur 4 lb., lime 3 lb. This treatment was repeated May 14 and 21 and June 6 and 17.
July 3 — Same treatment as April 24 only lead arsenate reduced to 2 lb. This treatment was repeated August 5.

B. April 6 — Delayed dormant with DN1/ solution.
April 24 — Gammexane (10% gamma isomer) 2 lb. "Mike" sulfur 4 lb.
May 14 — Same plus 1 lb. Mississippi bentonite.
May 21 — Same plus 2 lb. Mississippi bentonite.
June 6 — Gammexane 1 lb. "Mike" sulfur 4 lb.
June 17 — Gammexane 2 lb. DN-111 1 lb. - 25%DDT 4 lb. sulfur 4 lb.
July 3 — 25% DDT 4 lb. DN-111 1 lb. sulfur 4 lb.
Aug. 5 — Same as July 3 but without DN-111.

1/ Formulation containing sodium salt of dinitro-o-cresol, di cyclo hexyl amine salt of Di-nitro-cyclo-hexyl-phenate.

Table 4. European Red Mite Control, Westwoods, 1946

Treatment	Tree No.	Number of Adult Females per Leaf Aug. 6	Aug. 9	Aug. 15	Aug. 22
A. DDT plus Miticide 1/	C6	43.4	16.35	20.6	37.9
B. DDT plus Genicide	C8	1.3	0.1	0.35	2.5
	C10	.4	0.3	0.20	1.8
	C12	.3	0.5	1.25	4.0
C. "Syndeet" (with DDT)	C14	28.4	5.8	11.1	31.9
	C16	40.4	11.2	18.6	40.5
	C18	23.4	9.8	13.2	31.2

1/ For spray formula and dates see following page.

Spray Schedule:

All plots received a delayed dormant spray of oil and four early season sprays of lead arsenate and sulfur, prior to start of mite control tests.

Plot A. DDT plus hydroxy methyl flavan--formulation containing 25% DDT - 5 lb.-100 June 11. Same plus 4 lb. "Mike" sulfur-100 June 25, July 8, 26, August 8 (sulfur omitted).

Plot B. 25% DDT 6 lb., "Genicide" 2 lb. (with flocculant and spreader) and 3 pt. kerosene - June 11. Same without kerosene but 4-100 "Mike" sulfur June 25, July 8, 26, August 8 (sulfur omitted).

Plot C. "Syndeet" 1 qt. to 100 June 11. Same plus 4 lb. "Mike" sulfur June 25, July 8, 26, August 8. (sulfur omitted).

Table 5. European Red Mite Control, Cooke's Orchard, Branford, 1946. (Variety - Baldwin)

Treatment (Applied July 8)	Adult Female Mites per Leaf					
	June 25-8	July 3	July 10	July 17	July 24	July 30
DN-111 2 lb.-150	7.3	---	.05	1.5	2.5	4.8
plus 6 lb. 25% DDT	6.5	---	.8	3.1	1.7	2.7
	8.1	6.6	.2	7.3	3.2	5.4
	14.0	8.3	.4	3.0	2.0	4.3
6 lb.-150 plus Hydroxy methyl	8.3	---	3.3	14.9	13.1	10.2
flavan formulation containing	5.8	6.4	2.6	15.4	11.9	4.5
25% DDT	4.2	---	2.3	6.6	8.5	7.5
	8.8	7.2	5.0	20.7	17.6	5.0

Table 6. Control of Red-Banded Leaf Roller, 1946.
(Variety - Baldwin)

DDT Program		Arsenical Program		
Tree	Percent Injured Fruit	Tree	Percent Injured Fruit	Difference
C6	3.52	E6	1.43	+ 2.09
C10	5.84	E10	.36	+ 5.48
C12	8.01	G18	.00	+ 8.01
M25	1.11	O28	.24	+ .87
L7	3.03	L6	.25	+ 2.78
M7	4.25	M6	.07	+ 4.18
		Mean difference (Difference significant by statistical analysis)		3.90 percent

DELAWARE

L. A. Stearns, Delaware Agricultural Experiment Station, Newark.

Seasonal Conditions and Codling Moth Abundance

Transformation of overwintered codling moth larvae commenced during the last week in March. The first, spring-brood moth emerged in observation cages on April 15. The first moth was captured in bait traps on April 25. Emergence of this brood ended on June 21. Seven percent of the total emergence occurred in April; 87 percent in May; and six percent in June. The first, first-brood moth emerged on June 29, and emergence of this brood continued throughout July. Bait traps, operated from April 22 to August 15, inclusive, proved to be a wholly inadequate index of moth activity after June 1. Of the total moths collected by traps, less than 0.5 percent were captured in April; 95 percent were taken in May; 4 percent in June; and 1 percent in July. None were recorded in August. The réduction in codling moth abundance from 1945, for the four orchards in which bait traps were located, approximated 80 percent.

Crop loss from codling moth for the State as a whole was the lowest in 20 years. The reasons for this substantial decrease in infestation are not clear. It cannot be attributed entirely to the widespread use of DDT, since plantings in which the standard lead-oil-nicotine program was followed likewise showed very little damage. Apparently, it was not the result of unfavorable weather conditions, since unsprayed trees supported a normally high population of this insect. Parasitism was, as usual, an unimportant control factor.

Experimental Spraying for Codling Moth Control

A block of 19-year-old Red Delicious apples, 14 x 23 rows, planted 40' x 40', was available for tests. It was divided into 40 plots (28, including nine trees; 11, six trees; and one, four trees), which provided four replications for each of 10 treatments. Where possible, the count tree was the center tree of the plot.

Seven planned applications (a petal fall and six cover sprays) were made with a speed sprayer (rate, 15 gallons per tree) on the following dates: April 29, May 16, May 29, June 11, June 25, July 11, and July 23. An additional, over-all application of liquid lime sulfur (2 gallons/100 gallons) was required on May 3 against scab but the outbreak was not controlled. A heavy drop of small apples occurred and but a 15 percent crop matured.

Lead arsenate (3 pounds/100 gallons) was used in the petal fall spray for all treatments; flotation sulfur paste (45 percent), in the petal fall spray (12 pounds/100 gallons) and in the first cover spray (8 pounds/100 gallons) for all treatments, except in cases where summer oil was to follow; Fermate (1 1/2 pounds/100 gallons), in those exceptions and also in the second cover spray; and weak Bordeaux, (1/2-3-100) in the third, fifth and sixth cover sprays and (1-3-100) in the fourth cover spray.

The differentiation in insecticidal treatments after the petal fall spray and a summary of results are presented in the following table.

No.	Treatments after Petal Fall Spray 1/ Insecticides (Rate in Pounds per 100 Gallons, Unless otherwise specified)	Cover Sprays 1 5/16	2 5/29	3 6/11	4 6/25	5 7/11	6 7/23	Total Apples 2/	Percent 3/ Uninjured by Codling Moth	Residue on Harvested Fruit Grain/lb. DDT	As_2O_5	Total No. Red Mites per Leaf 4/	Av. No. Apples per Bushel
1	DDT	1	.75	.75	1	.75		3919	95.5	.02		.8	149
2	DDT DN-111	1	.75 1.25	.75	1 1.25	.75 1.25		4557	96	.02		.1	147
3	DDT Genicide	1	.75 1	.75	1 1	.75 1		4829	98	.02		.3	150.5
4	DDT Lead Arsenate Genicide	4	.5 3	.5 3	.5 3 1	.25 3 1	3	6574	98	.01	Trace	.3	142
5	DDT Lead Arsenate Summer Oil (83%)	.5 3	.5 3 qt.	.5 3 qt.	.5 3 3 qt.	.5 3 qt.	.5 3 qt.	3161	99	.01	Trace	.1	164
6	Lead Arsenate Genicide-A	4	2	2	2	2		5633	95	Trace	Trace	.025	141
7	Lead Arsenate	4	4	4	4	4	4	5451	96		Trace	2.3	145
8	Lead Arsenate Summer Oil (83%) Nicotine Sulfate (40%)	4	4 3 qt. .75 pt.	4 3 qt. .75 pt.	4	4	4 3 qt. .75 pt.	7156	93		Trace	.8	149

1/ Numbers 9 and 10 with 3956, an experimental material, omitted.
2/ Harvested September 6.
3/ Procedure set forth in U.S.D.A., ET-215 followed in sampling fruit.
4/ Total recorded on August 7, 16, and 26

GEORGIA

Grover C. Freeman, Fruit Pest and Parasite Laboratory, Cornelia.

1. Seasonal Conditions and Status of Codling Moth Infestations During 1946.

Delicious buds were cracking open and ready for delayed dormant March 13. Most varieties were in full bloom April 1st and ready for calyx about April 6th.

The weather was moderate but very rainy March 1 to 20. A fairly heavy frost occurred the morning of April 13 and killed up to 40 or 50 percent of apples in low places in the Cornelia area. High places got by with little or no injury. At Tiger, Ga., severe damage appears to have been done to most varieties except Red Delicious.

The first codling moths were taken in bait traps in the Cornelia area April 4th. Total codling moths caught in traps for this year was 165, a much lower total than in previous years. The peak number was 48 moths in the month of August.

2. Control Experiments.

Eighteen trees were sprayed with DDT and 10 with lead arsenate in a comparison of these materials on the variety Kinnard in the Paul Fitts orchard at Cornelia, Ga. Results at harvest and (September 25) as indicated by picking and examining 250 apples on the four center trees, all of which bore a good crop, in each plot were as follows:

Treatment	TOTAL		
	Apples Examined	Worms	Stings
DDT	1000	5	27
Lead Arsenate	1000	10	282

3. Distribution of <u>Trichogramma minutum</u>.

A total of 29,920,000 T. minutum parasites was mailed to apple growers in 18 counties of Georgia.

Total each month, June, 3,344,000; July, 10,336,000; August, 10,565,000; September, 5,675,000.

IDAHO

H. C. Manis, Agricultural Experiment Station, Moscow.

We have not been conducting any detailed research work on codling moth control using DDT here in Idaho. Most of our work along this line has been of an extension nature and where it has been used according to our recommendations, very excellent control has been obtained.

There was some build up of woolly apple aphids and spider mites in the orchards where DDT was used; however, by observation the populations did not build up any more in DDT treated orchards than those where the lead arsenate spray schedule was followed. Some of our orchardists included DN with each of their sprays and as a result kept down populations of spider mites. All DDT applications were on by not later than July 15 and apparently parasites began to build up again within the orchards and stopped the increases of woolly apple aphids.

There were one or two cases where the new material Vapatone (hexaethyl tetraphosphate) was tried out for the control of woolly aphids and mites and the results reported to me were very satisfactory.

ILLINOIS

S. C. Chandler, State Natural History Survey Division, Carbondale.

Experimental work on codling moth was conducted in 14 orchards in nine counties over a territory stretching about 300 miles. In most of these orchards, DDT was compared with a standard schedule; and in some, information was sought on a number of points indicated in the conclusions. Two tree-plots in the University orchard at Urbana were designed to secure data on oil-DDT injury and safeners. A dormant eradicant spray of dinitro-ortho-cresol in a miscible oil (Dendrol) was used in one orchard (Rendleman, see tables). Ryanex was used in second-brood sprays in two orchards (Trobaugh and Ringhausen).

To save space, the spray schedules of these 14 orchards are not given in detail but are analyzed and the most important data given in Table 1. Table 2 contains the records of picked fruit and condition of fruit and foliage at harvest, with notes on other pests affected by the use of DDT. Eliminating much of the explanation and discussion which should accompany these tables, the following conclusions are drawn:

1. Comparison of DDT with standard spray materials.

The percentage of wormy apples in all DDT plots average 4.4 as compared with 9.6 in standard blocks, a ratio of 1 to 2.2. In 1945, the ratio was 1 to 3.

2. Comparison of efficiency of DDT in combination with lead arsenate and with fixed nicotine.

No significant differences this year, though most of the combinations with nicotine were the commercial mix BL 155 X or Y. In 1945, the combination with lead arsenate was somewhat superior.

3. Combinations of DDT with lead arsenate.

Of the four dosages shown in Table 1, the smallest, lead arsenate 2 pounds, DDT 1/4 pound, seems about as efficient as the heavier ones. This was true in 1945 under conditions of heavier infestation and is important because smaller dosages mean less injury, less residue and less of the other troubles which accompany the use of DDT.

4. Efficiency of DDT as wettable powder and in oil solution.

Standard Oil Company's "Nonpareil" was tested in two orchards. Where equal numbers of applications of wettable powdered DDT were used in adjoining blocks (Smith orchard, Table 2), control was approximately equal; but where fewer applications were interspersed with Nicosol (Nugent & Schapanski orchard), control was somewhat inferior to the wettable powdered DDT.

5. Use of oil with DDT to increase codling moth control.

In the Foreman orchard, an increase in control was noted where summer oil was used twice with DDT, but the low level of infestation makes significance of data doubtful. Excellent control was obtained in Heaton orchard with oil used in one of eight DDT applications, as compared with standard schedule.

6. Use of other materials for codling moth control.

A dormant eradicant spray of dinitro-ortho-cresol in Dendrol gave better control than the check in the Rendleman orchard, but the low level of infestation due to a heavy DDT spray schedule reduces the value of infestation data.

Three second-brood applications of Ryanex with summer oil following first-brood sprays of DDT combinations in the Ringhausen and Trobaugh orchards gave poorer control than when the DDT was continued throughout the season.

7. Control of other pests associated with use of DDT.

   A. Mites. In general, the mite damage was light this season in the experimental orchards, probably due to seasonal conditions. Very definite control of the two-spotted spider mite was obtained in the Smith orchard with Nonpareil, as shown in Table 2.

   B. Leafhoppers. Although leafhopper injury was gonerally light, leaf hopper control in DDT plots was superior to that in standard-sprayed blocks.

   C. Red-banded leaf rollers. The red-banded leaf roller has generally increased in DDT-sprayed orchards, but to date has been light in our experimental orchards. The records in the Trobaugh orchard confirm other data showing that higher dosages of DDT (1 pound to 100 gallons alone) result in higher infestation than lower dosages with lead arsenate or nicotine. The records in the Sauer orchard give some indication that DDT combined with nicotine may result in greater infestation than when combined with lead arsenate.

8. Oil-DDT injury and use of safeners. From the tests in the University orchard, though certain inconsistencies appear in Table 2, the following facts seem fairly clear:

   A. DDT alone did not injure foliage.

   B. Oil-DDT caused appreciable injury, especially in larger dosages.

   C. In most cases, the soy-lime slurry or soy paste alone did not prevent injury.

   D. There was somewhat less injury with oil-DDT when combined with BL 155 X and Y than when combined with lead arsenate.

   E. Nonpareil with or without its safener, Mississippi bentonite, gave little or no injury.

In the other experimental orchards, in some cases there was practically no oil-DDT injury, regardless of the use of safener. In other cases, despite its use, injury took place. The resistance of varieties like Winesap shown last year held this season. Laboratory work at the University of Illinois this year showed that oil-DDT injury is largely a matter of degree of agitation, and will occur regardless of safeners used if agitation is sufficient.

9. Russeting and lack of color. Both were noticeable in DDT blocks in 1945, but little difference was noted in 1946 between DDT and standard blocks.

Table 1. Data from Spray Schedules in DDT Experiments in Illinois, 1946

Orchard	Plot No.	Total No. Sprays	Date Last Spray	Number of Applications with 1/ Lead Ars. Alone	Nicotine Alone	Lead and Nicotine	DDT & Nicotine	DDT Alone 3/4-1	DDT 1/4 Lead 2	DDT 1/2 Lead 2	DDT 3/8 Lead 2	DDT 3/8 Lead 3	Oil with DDT	Soy-Lime Safener	Other Insecticides
Smith Johnson Co.	1	10	8/5	4				6 2/					6 2/		
	2	10	8/5	4	1		1		4				5	4	
	3	10	8/5	6	1	2	1						1	0	
Heaton Johnson Co.	1	12	8/26	9	3										
	2	12	8/26	4			3				5		1	1	
Trobaugh Jackson Co.	1	11	8/15	11											
	2	11	8/15	2				9					0		
	3	11	8/15	3	2		1			2			0		3-Ryanex-oil 5 lb. 2 qt.
Springdale Jackson Co.	1	8	7/22	6	2										
	2	8	7/22	3			2					3	2	2	
Sauer Jackson Co.	1	9	8/21	9											
	2	9	8/21	3					6				3	0	
	3	9	8/21	3	6 3/										
	4	8	8/21	3	5 4/								2	0	
	5	9	8/21	3	6 5/								3	0	
Rendleman Union Co.	1	15	7/25	3			2	1 2/			9		2	0	Dormant DNC
	2	15	7/25	3			2	1 2/			9		2	0	Check, no DNC
Gage-Hawkins Jefferson Co.	1	9	8/11	3	1			5					4	4	
	2	9	8/11	8	1										
	3	9	8/11	3	1						5		3	3	
Eckert St. Clair Co.	1	10	8/10	4	5	1									
	2	10	8/12	2	2		2	1			2	1	2	2	
Ringhausen Calhoun Co.	1	9	8/10	3				2		4		5	5	3	
	2	9	8/10	9											
	3	9	8/10	3						3					3-Ryanex-oil 5 lb. 2 qt.

See end of Table for foot notes.

Table 1. Data from Spray Schedules in DDT Experiments in Illinois, 1946 (Continued)

Orchard	Plot No.	Total No. Sprays	Date Last Spray	Number of Applications with [1] Lead Ars. Alone	Nico-tine Alone	Lead and Nico-tine	DDT & Nico-tine	DDT Alone 3/4-1	DDT 1/4 Lead 2	DDT 1/2 Lead 2	DDT 3/8 Lead 2	DDT 3/8 Lead 3	Oil with DDT	Soy-Lime Safe-ner	Other Insecticides
Foreman	1	9	8/16	2	3							4	2	0	
Pike Co.	2	9	8/16	2	3							4	0		
Nugent &	1	13	8/15	3	10[3]	1									
Schapanski	2	13	8/15	3		1	10[4]						9	0	
Jersey Co.	3	13	8/15	3		1	10[5]						9	0	
	4	13	8/15	3	5	1		4[2]					4[2]		
	7	13	8/15	12		1									
	8	13	8/15	3	4	1	.3	1		1			4	0	
Coffman	1	11	8/23	3	4		2				2		1	0	
Pike Co.	2	11	8/23	3	6	2									
Thornton	1	12	8/21	5	5										
Adams Co.	2	12	8/21	5	2		3[8]		2[7]				5	5	
	3	12	8/21	5	2		3[8]			2[7]			5	5	
U. of I.	A	5	7/16					5					0		
Urbana	B	5	7/16					5					5[9]	0	
	C	5	7/16					5					5[10]	0	
	D	5	7/16					5					5[9]	5	
	E	5	7/16					5					5[10]	5	
(2 tree plots)	F	5	7/16							5[11]					
	G	5	7/16							5[11]			5[9]		
	H	5	7/16							5			0	5	
	I	5	7/16		5								5		
	J	5	7/16				5						5	5[6]	
	K	5	7/16				5						5	0	
	L	5	7/16				5						5	0	
	M	5	7/16				5						5	5[6]	
	N	5	7/16					5[2]					5[2]	0	
	O	5	7/16					5[2]					5[2]		N. Bentonite safener

See following page for foot notes.

Footnotes for Table 1

1/ The word "alone" in headings means with no other poisons, but may be used with fungicides or oil.

2/ DDT dissolved in oil-Standard Oil Company's Nonpareil used at 3 quarts per 100 gallons with 1 1/2 pounds Mississippi Bentonite as safener.

3/ Black Leaf 155

4/ Black Leaf 155 X

5/ Black Leaf 155 Y

6/ No lime used in safener because of nicotine.

7/ Black Leaf 155 added in one application.

8/ Plot 2 Thornton Orchard 1/4 pound DDT, Plot 3, 1/2 pound DDT added to the nicotine.

9/ 2 quarts oil

10/ 1 quart oil

11/ Bordeaux 1/2-1-100 added.

Table 2. Final Harvest Records in DDT Experimental Orchards in Illinois, 1946.

Orchard and Variety	Plot No.	Materials Used Chiefly in Plots (Amounts per 100 Gallons)	Percent of Apples: Codling Moth Wormy	Percent of Apples: Codling Moth Stung	Percent of Apples: Red Banded Leaf Roller Injury	Mite Injury	Leaf-hopper Injury	Oil-DDT Injury	Fruit Color Differences at Maturity
Smith (Jonathan)	1	Nonpareil	6.1	7.0	light	2.25 1/	light	light	none
	2	Lead ars., DDT, slurry 2/	6.8	10.5	to	34.50 1/	light	moderate 3/	none
	3	Lead-nicotine split schedule	12.9	11.4	none	1.50 1/	light	none	none
(Kinnard)	1	As above	10.4	13.9	as above	light	light	light	none
	2	As above	8.9	20.1	as above	moderate	light	moderate	none
	3	As above	19.0	23.4	as above	light	light	none	none
Heaton (Kinnard)	1	Lead-nicotine, oil in 1 spray	10.5	14.7	light to	light	light	none	none
	2	Lead, DDT, nicotine, Oil once	2.0	5.7	none	light	light	none	none
Trobaugh (Delicious)	1	Lead, lime, oil	9.3	17.0	none	none	moderate		none
	2	DDT 1 lb., no oil	3.7	17.1	6.4	light	none		none
	3	Lead, DDT early; Ryanex 2nd brood	8.7	22.1	.6	light	light	light	none
Springdale (Winesaps)	1	Lead, nicotine	3.7	7.1	none	none	severe		none
	2	Lead, DDT, oil, slurry	4.2	4.0	none	light	light	none	none
Sauer (Winesap)	1	Lead, lime, oil	7.5	18.8	0.0	none	severe		none
	2	Lead, DDT, oil, no slurry	5.8	14.1	0.0	none	light	none	none
	3	BL 155, oil	4.7	7.7	.6	none	light		none
	4	BL 155 X, oil, no slurry	4.2	8.0	1.6	none	light	none	none
	5	BL 155 Y, oil, no slurry	5.2	11.3	1.7	none	light	none	none
Rendleman (Winesap)	1	Lead, DDT (dormant DNC eradicant)	.5	1.7	none	none	light	light	none
	2	Lead, DDT (check, no dormant)	2.6	3.0	none	none	light	light	none
Gage-Hawkins (Jonathan)	1	DDT alone 1 lb., oil, slurry	.1	.7	light	light	very light	light	none
	2	Lead, weak Bordeaux, oil	.4	.4	none	none	very light		none
	3	Lead, DDT, oil, slurry	.1	.3	none	none	very light	very light	none
Eckert (Stayman)	1	Lead, nicotine	19.8	12.3	none	light	light		none
	2	Lead, DDT, nicotine, oil, slurry	13.3	10.1	very light	light	none	none	none

1/ Numbers of mites on three leaves, August 10 (average).

2/ Slurry made of soy flour and lime, usually 2 ounces each, per 100 gallons as oil-DDT safener. Lime omitted when nicotine used.

3/ Severe oil-DDT injury on Golden Delicious trees interplanted in this block.

Table 2. Final Harvest Records in DDT Experimental Orchards in Illinois, 1946. (Continued)

Orchard and Variety	Plot No.	Materials used Chiefly in Plots (Amounts per 100 Gallons)	Percent of Apples: Codling Moth, Wormy	Percent of Apples: Codling Moth, Stung	Percent of Apples: Red Banded Leaf Roller Injury	Mite Injury	Leaf-hopper Injury	Oil DDT Injury	Fruit Color Differ-ences at Maturity
Ringhausen (Willow Twig)	1	Lead, DDT, oil, slurry	4.1	4.1	.1	light	none	none	none
	2	Lead, lime, oil	3.7	10.0	0.0	light	moderate		none
	3	Lead, DDT first brood; Ryanex 2nd	7.4	7.0	0.0	light	none	none	none
Foreman (Mixed Var.)	1	Lead, DDT, nicotine, 2 oils	.8	2.7	very light	light	none	none	none
	2	Lead, DDT, nicotine, no oil	1.2	1.8	very light	light	none	none	none
Nugent & Schapanski (Jonathan)	1	BL 155, oil	13.2	2.6	none	very light	light	none	none
	2	BL 155 X, oil, no slurry	4.2	3.4	none	very light	light	very light	none
	3	BL 155 Y, oil, no slurry	5.4	2.4	none	very light	light	very light	slightly less russet
	4	Nonpareil, nicotine	9.3	2.7	none	very light	light	very light	none
	7	Lead, Bordeaux 1/2-1, oil	9.7	4.5	none	very light	light		none
	8	Lead, DDT, nicotine	3.7	2.0	none	very light	light	light	none
	Check	No treatment after 1st cover	73.5	3.5	none	very light	light	light	
Coffman (Delicious)	1	Lead, DDT; then nicotine, no slurry	5.3	5.6	no count	light	light	very light	none
	2	Lead-nicotine split schedule	17.3	21.3	no count	light	light		none
Thornton (Delicious)	1	Lead-nicotine split schedule	2.4	5.9	none	none	light		none
	2	Lead-nic., DDT 1/4 lb., oil, slurry	3.6	7.1	none	very light	light	very light	none
	3	Lead-nic., DDT 1/2 lb., oil, slurry	3.4	3.0	none	very light	light	very light	none
Univ. of Ill. (Jonathan)	A	DDT 1 lb., no oil	No fruit				light	none	
	B	DDT 1 lb., oil 2 qts.					light	severe	
	C	DDT 1 lb., oil 1 qt.					light	moderate	
(2 tree plots)	D	DDT 1 lb., oil 2 qt., slurry					light	severe	
	E	DDT 1 lb., oil 1 qt., slurry					light	severe on one	
	F	DDT 1/4 lb., lead 2, Bord. 1/2-1					light	moderate	
	G	DDT 1/4 lb., lead 2, Bord. 1/2-1, oil 2 qt.					light	moderate	
	H	DDT 1/4 lb., lead 2, slurry					light	light	
	I	BL 155, oil 2 qt.					light	none	
	J	BL 155 X, oil 2 qt., slurry					light	light	
	K	BL 155 X, oil 2 qt.					light	light	
	L	BL 155 Y, oil 2 qt.					light	light	
	M	BL 155, oil 2 qt., slurry					light	light	
	N	Nonpareil, 3 qt.					light light	light light	
	O	Nonpareil, 3 qt., Miss. Bentonite 1 1/2 lb.					light	none	

ILLINOIS (Continued)

Carl J. Weinman, State Natural History Survey Division, Urbana.

Codling Moth Experiments in Illinois, 1946

Tests on the relative effectiveness of DDT, benzene hexachloride, 3956, and 1068 were conducted in the University orchards at Urbana, Illinois. These materials were used alone (without oil or other insecticide) throughout the season, and counts were made during the season and at harvest. Every apple in every plot was counted, and all apples or else large samples from each tree were graded.

Results of representative plots in this experiment appear in Table 1. Figures are based on total crop (i.e. all drops and picks). Each plot contained at least two trees, and some contained as many as eight. All of the records in Table 1 are on 20-year-old Winesap trees. Three first-brood and three second-brood sprays were applied between May 30 and August 19.

Table 1. Results of Tests on New Insecticides at Urbana, Illinois, 1946.

Treatment	Total Crop	Percent Drops	Percent Entered Fruit	Percent Stung Fruit	Total Entries per 100 Apples	Total Stings per 100 Apples
DDT wettable powder 1 lb. actual DDT	608	44.2	4.1	5.9	5.1	6.7
Same, 1/2 lb. DDT	1,748	40.5	8.9	5.4	13.2	7.8
1068 emulsion 1 lb. actual 1068	1,312	57.8	66.2	5.7	127.8	19.5
1068 wettable powder 1 lb. actual 1068	172	79.7	59.3	5.2	114.5	20.4
Same, 1/2 lb. 1068	615	76.8	81.0	6.0	369.8	29.3
3956 wettable powder 1 lb. actual 3956	731	74.0	38.7	8.3	58.7	14.0
Same, 1/2 lb. 3956	589	83.9	74.4	4.9	154.7	16.0
3956 emulsion 1 lb. actual 3956	1,332	55.2	60.7	5.0	141.3	21.6
Same, 1/2 lb. 3956	469	64.0	66.5	10.0	165.9	42.2
Benzene hexachloride wettable powder 0.17 lb. gamma	672	52.4	65.6	6.6	138.2	17.4
Same, .09 lb. gamma	390	61.8	45.1	10.0	72.3	23.1
Lead arsenate, Summer oil	1,606	21.4	1.3	9.8	2.1	14.7
Zinc fluoroarsenate Summer oil	712	68.0	8.3	15.6	16.0	20.2

Table 1 clearly shows that none of the new chlorinated hydrocarbons approaches DDT in effectiveness. Replicate plots involving Golden Delicious, Transparent, Wealthy, Jonathan, and other Winesap trees gave the same general results. The zinc fluoroarsenate, used without a safener in the second-brood sprays, caused serious foliage injury, but no injury was apparent on the other plots.

Representative samples of mature fruit from various plots were submitted to Dr. Frances O. Van Duyne of the University's home economics food laboratory for taste tests. The three judges tasted both the fresh fruit and sauce made from the apples. In every instance except one and on every variety tested, they were able to discern the fruit sprayed with benzene hexachloride. This was true even with Winesap apples which had not been sprayed for two months before harvest.

In a cooperative experiment with the University department of horticulture, Dr. Dwight Powell and I conducted an experiment on the airplane application of insecticides and fungicides on a 25-acre orchard near Payson, Illinois (Adams County). In this experiment, we started with a lead-arsenate dust, changed to a DDT dust early in May, and then shifted to a 1068 spray. We were getting very poor coverage from the dusts, but deposits from aerial applications of sprays were fair to satisfactory. By the middle of June, we discovered that 1068 was ineffective against codling moth, so we changed to a DDT spray. Although there was a tremendous build-up of first brood worms during the application of 1068, we were able to show definite control from the use of DDT.

The dust applications were made through a venturi apparatus attached under the fuselage of a 225 H.P.Stearman (biplane). The sprays were applied through modified spinner discs attached at each lower wing tip and under the fuselage. Later, to increase the output, a perforated air-foil bar was added just above the center spinner disc. The spray plane was a 235 H.P. N-3-N Navy trainer.

Applications were made at the rate of 1 pound of 1068 or DDT emulsified in 6 gallons of water per acre.

INDIANA

G. Edward Marshall, Indiana Agricultural Experiment Station, Orleans.

Seasonal Conditions

The 1946 season started out to be early but unfavorable weather in the late spring brought codling moth activity to a standstill for a long period after it had developed very rapidly earlier. The first noticeable hatch of eggs in the orchard began May 22. As in 1945, a late summer drought provided conditions favorable to the rapid increase of the codling moth during that period and increased injury to fruit resulted. A light crop made the attack by the codling moth seem more severe than usual.

Field Tests

The codling moth plots at the Elrod orchard in 1946 received basically the same treatment as they did in 1943, 1944 and 1945. The same plot treatments were used on the same trees all these years. This was done in order to provide specific answers to growers' questions and to find the comparative effects of these schedules on the photosynthesis and transpiration as reflected in the total crop. The treatments used have been proven to be the best we knew of before the 1946 season when commercial orchardists began using DDT. Each of the four schedules contain groups or combinations of materials which are practical and which will probably be used more or less regularly even though DDT may replace them in some measure. Each schedule if diligently and thoroughly used and if fortified by good sanitational measures as well as bait trap data for timing sprays on years during which the codling moth is especially bad will control the insect to the point where the wormy fruit will be held to 15 percent or less and will do so with a minimum of foliage injury.

Table 1 provides most of the information as to the number of sprays applied in 1946 and the measure of control obtained.

Table 1. Spray Schedule and Infestation Counts - Elrod Orchard, 1946.

Plot	Cover 1/ Sprays	Materials (Amounts per 100 Gallons)	Date of Sprays	Harvest Infestation per 100 Apples Worms	Stings	Affected
1	3	5# WB, 1 pt. BL 40, 1 qt. SBO	June 12-14			
	4	3# LA, 1/2 gal. MO	June 22			
	5	3# BL 155	July 3	26.4	63.2	45.5
	6	8# WB, 1 pt. BL 40, 1 qt. SBO	July 19			
	7	8# MB, 1 pt. BL 40, 1 qt. SBO	July 31-Aug. 1			
	8	6# MB, 2/3 pt. BL 40, 1 qt. SBO	Aug. 12			
	9	6# MB, 2/3 pt. BL 40, 1/2 gal.MO 1 pt. SD	Aug. 27-28			
2	3-4-5	3# LA, 1/2 gal. MO	June 13-17			
	6	3# LA, 1# L, 1# $ZNSO_4$,	June 17			
		1/2 gal. MO	June 25			
	7	3# LA, 3# L, 3# $ZNSO_4$,	July 3	44.3	182.3	55.7
		1/2 gal. MO	July 20			
	8-9	3# LA, 3# L, $ZNSO_4$,	Aug. 1			
		1/2 gal. MO	Aug. 7-8			
	10	6# MB, 2/3 pt. BL 40, 1/2 gal. MO, 1 pt. SD	Aug. 28			
3	3-4	3# BL 155, 1/2 gal. MO	June 11			
	5-6	3# BL 155	June 14			
	7	2# BL 155	June 21	68.6	99.8	62.2
	8	2# BL 155, 1/2 gal. MO	July 2			
	9	3# BL 155	July 19-20			
	10	3# BL 155, 1/2 gal. MO	July 26			
	11	3# BL 155	July 31-Aug. 1			
	12	3# BL 155, 1/2 gal. MO	Aug. 8-9			
		1 pt. SD	Aug. 21-30			
4	3	4# LA, 1/2 gal. MO, 1 pt. BL 40	June 12-17			
	4-5	4# LA, 1/2 gal. MO, 1/2# S	June 17			
	6-7	5# WB, 2# 1 oz. S, 1/2 gal. MO	July 22-23	37.0	218.5	59.7
		1# ALSO	July 23			
	8	5# MB, 2/3 pt. BL 40, 1/2 gal.	July 31-Aug. 1			
		MO, 1 pt. SD	Aug. 28			

1/ The entire orchard received the delayed dormant application within the week of March 17. Scab sprays which were applied to the entire orchard were the prepink March 25, the pink March 30, early bloom April 2, calyx April 18 to 20, calyx top-off April 20 to 24. On May 4 to 8 the first cover was applied as a blanket treatment to the entire orchard and the spray contained 3 pounds lead arsenate with a sulfur fungicide. This was an outside-under application. On May 28 to 30 an outside application, the second cover, went on and this contained 3 pounds lead arsenate with 1 pound of Fermate.

LA - Lead Arsenate	ZNSO - Zinc sulfate	WB - Wyoming bentonite
MB - Mississippi Bentonite	SBO - Soy Bean Oil	L - Lime
MO - Mineral Oil	BL 40 - Black Leaf 40	S - Soap
SD - Stop Drop	BL 155- Black Leaf 155	

KANSAS

R. L. Parker and E. L. Eshbaugh, Kansas Agricultural Experiment Station, Manhattan.

Introduction

Studies on the control of codling moth on apples were continued in 1946 by the entomological staff of the Northeast Kansas Experiment Fields at Blair, Kansas. Comparative tests of certain insecticide combinations as substitutes for lead arsenate in spraying for the control of codling moth and for the prevention of red spider mite infestations were conducted. The apple variety used was Jonathan.

Methods and Procedure

Two single tree replicates were used for each insecticide or combination of insecticides tested. The replicates were randomized in nine rows of trees containing ten trees each. Two early sulfur sprays were applied to the plots for apple scab control. Lead arsenate at the rate of 4 pounds to 100 gallons of water was applied uniformly to all trees in all plots in the calyx spray. Summer oil emulsion was left out of the sprays used on the lead arsenate-zinc sulfate plots after the sixth cover spray.

Seven cover sprays were applied to the DDT, DMT, "Miticidal DDT", and hexachlorocyclohexane spray plots. The lead arsenate, fixed nicotine, and fixed nicotine-DDT plots received nine cover spray applications.

To prevent excessive fruit drop, two hormone spray applications of naphthalene acetic acid were applied to the trees in the spray plots, the first August 16 and the second August 28. These prevented excessive fruit drop through the completion of harvest September 21.

Wormy, stung, and clean dropped apples per tree were recorded at intervals during the summer. Preharvest dropped apples were collected and recorded August 24 through September 16. A harvest count of 500 fruits per tree was made September 16 through 21.

Seasonal Conditions and Codling Moth Abundance

First Brood. Unseasonably warm weather in February and March resulted in an early emergence of overwintering brood moths. The first moths from the overwintering generation of larvae were in bait traps

April 22, almost a month earlier than in 1945. By April 26, moth emergence was well under way. The largest trap catch during the first brood occurred April 29. Following this emergence cool, rainy weather delayed development. The first larval entry was noted on May 7. No other entries were noted until May 13. The heaviest hatch of larvae occurred June 3 to 10. By June 4, catches of overwintering brood moths in bait traps began to diminish. A period of little moth activity occurred from June 19 to July 3 when no moths were caught in bait traps. First brood damage was light.

Second Brood. On July 3, bait trap catches and emergence cages indicated that the first brood moths were emerging. Steady bait trap catches with few highs and lows characterized this brood. There were, as with the first brood, no outstanding peak catches; only days of alternating high and low catches which closely followed weather conditions. Damage from second brood larvae was steady and consistent after July 10 due to favorable weather conditions for development.

Third Brood. Weather conditions favoring the development of codling moth resulted in a partial third brood in northeast Kansas. An advanced season with almost no rain and favorable daily temperatures during the second brood caused a rapid development of codling moths. Codling moth activity increased August 18 to September 13 resulting in large moth catches and a large hatch of larvae. The most severe damage of the season was from third brood larvae. The operation of bait traps was discontinued September 20, although moths were still being caught.

Seasonal Damage

Although codling moths were as numerous near the end of the 1946 season as in previous years, control was good in most orchards receiving the required number of first, second, and third brood sprays or a total of nine cover sprays. The last three cover sprays of 1946 were the most important sprays for protecting the crop from the late large hatch of larvae. Some growers who failed to apply the last two recommended sprays of the season had a large number of wormy and stung harvested fruits.

Materials and Dosages

The combinations of insecticides used in 1946 are indicated in Table I.

Table I. Insecticides, dosages, and schedules used in cover sprays for codling moth control, 1946.

All plots had a calyx spray of lead arsenate, 4 pounds.

1. Lead arsenate, 4 lb. 1/

2. Di(methoxyphenyl)trichloroethane, (DMT) (Methoxy), 2 lb. 50% (1 lb. DMT), 7 cover sprays, a DDT analog. No oil.

3. Lead arsenate, 4 lb., plus zinc sulfate, 4 oz., plus "Superla" oil emulsion, 1 qt. Oil left out after 6th cover spray.

4. "Miticidal DDT", 5 lb., 16.66% DDT, 20% hydroxy pentamethyl flavan (13 1/3 oz. DDT), 4th through 7th cover sprays. No oil. First through 3rd covers, 2 lb. 50% DDT, (1 lb. actual).

5. DDT, 2 lb. 50% DDT, (1 lb. DDT), 1st through 7th cover sprays. No oil.

6. "Black Leaf 155" (12% nicotine from 40% soluble nicotine) plus "Superla" oil emulsion. "B. L. 155", 3 lb., 1st and 2nd covers; "B. L. 155", 2 lb. plus "Superla" oil 1 qt., 3rd through 9th covers.

7. "Black Leaf 155X" (12% nicotine from 40% soluble nicotine plus 7% DDT) plus "Superla" oil emulsion. "B. L. 155X", 3 lb., 1st and 2nd covers; "B. L. 155X", 2 lb., plus "Superla" oil, 1 qt., 3rd through 9th cover sprays.

8. "Black Leaf 155Y" (12% nicotine from 100% soluble nicotine plus 7% DDT) plus "Superla" oil emulsion. "B. L. 155Y" 3 lb., 1st and 2nd covers; "B. L. 155Y" 2 lb., plus "Superla" oil, 1 qt., 3rd through 9th covers.

9. Hexachlorocyclohexane, 2 lb., 50% (5% gamma isomer), 1st through 7th covers. No oil.

1/ All quantities indicate amount per 100 gallons of spray.

As in past years, information for spray dates was obtained from two sets of codling moth bait traps. Through a cooperative arrangement with the entomological staff of the Northeast Kansas Experiment Fields, the Doniphan County Farm Bureau informed growers concerning spray dates and also furnished growers with a weekly summary of codling moth catches listed for each day of the preceding week.

Spray dates for 1946 were as follows: Calyx, April 23; first cover, May 4; second cover, May 15; third cover, May 27; fourth cover, June 8; fifth cover, June 25; sixth cover, July 8, seventh cover, July 19; eighth cover, August 2; and ninth cover, August 16. A tenth cover spray was recommended for application on August 29, but it was not applied to the codling moth plots.

At harvest time samples from all but two plots were collected and analyzed for arsenical, DMT, and DDT residue.

Results

Data for the various insecticide tests for the control of codling moth in the Blair experiment orchard at Blair, Kansas, are recorded in Table II.

Table II. Percentages of wormy and stung apples during various periods and the entire season, and residue analyses, 1946.

Treatment Number	Apples dropped to August 24			Preharvest drops September 16			Harvest counts		Summary (entire season)				Residue (grains As_2O_3 per lb.)[5]		Residue (grains DDT of DMT per lb.[5]	
	Total per plot	Per cent wormy	Per cent stung	Total per plot	Per cent wormy	Per cent stung	Per cent wormy	Per cent stung	Total per plot	Per cent wormy	Per cent stung	Per cent clean	unwashed	washed	unwashed	washed
1	255	0.8	0.1	384	2.1	3.1	0.9	3.6	1639	1.2	3.4	95.4	0.194	0.021	----	----
2	264	3.8	0.4	376	4.3	2.1	1.7	1.2	1640	2.6	1.3	96.1	----	----	0.038	0.027
3	243	5.8	1.6	249	0.8	3.2	1.5	2.1	1492	2.1	2.2	95.7	0.294	0.029	----	----
4	137	3.7	0.7	301	10.0	1.0	3.0	1.6	1438	4.5	1.4	94.1	----	----	0.027	0.028
5	117	0.0	0.9	303	2.0	0.7	1.2	0.4	1420	1.3	0.5	98.2	----	----	0.058	0.046
6	116	6.0	1.7	174	3.4	1.2	3.7	2.8	1290	3.9	2.5	93.6	----	----	----	----
7	217	5.1	0.4	409	2.2	0.5	1.3	0.4	1626	2.0	0.4	97.6	----	----	0.048	0.030
8	208	1.0	0.0	664	0.6	0.9	1.1	0.6	1872	0.9	0.6	98.5	----	----	0.021	0.027
9	365	52.6	0.8	332	71.7	1.8	48.2	3.2	1697	53.7	2.4	43.9	----	----	----	----

[5]Residue analyses were made by Dr. A. T. Perkins, Analytical Laboratory, Kansas Agricultural Experiment Station.

Discussion

In recording the data from injured fruits, multiple stings or larvae in a single fruit were not considered. When a fruit had both stings and larvae present, it was recorded as "wormy."

On July 2, an examination of trees in the plots and trees surrounding the plots showed the presence of red spider mites. Few mites were found except on trees outside the plots sprayed with DDT in 1945. By July 12 the red spider mite population had increased and many eggs were found on leaves of trees sprayed with DDT in 1945. The leaves had over 200 red spider mites per leaf and were beginning to turn a light bronze color. Leaves on trees surrounding the plots and sprayed with DDT-lead arsenate in 1946 were beginning to turn a light bronze color by July 24. No mites were found on leaves of trees in plots sprayed with "DDT (Deenate 50-W)," "Black Leaf 155X" plus summer oil emulsion or "Black Leaf 155Y" plus summer oil emulsion. Although some red spider mites could be found in the remainder of the spray plots, the population was not large enough to cause injury to the leaves on the trees.

The foliage on all trees of the spray plots at the Blair experimental orchard appeared in good condition on July 30, except for the "Black Leaf 155Y" plus oil and the "lead arsenate without safener" plots where some yellow leaves had appeared on the trees. This condition continued throughout the remainder of the season, resulting in a severe loss of leaves and heavy pre-harvest apple drop from the trees in these two plots.

On July 19, one half of a tree not included in the test plots and showing severe red spider mite injury was sprayed with "Miticidal DDT." The other half of the tree was not sprayed with a miticide. At the time the tree was sprayed with "Miticidal DDT," as many as 160 mites and 120 eggs were counted on each leaf. On July 24, the mites on the half of the tree sprayed with the miticide had been reduced to 0 to 5 per leaf. Red spider mites on the portion of the tree left unsprayed had increased to more than 200 per leaf.

Red spider mites caused the loss of some leaves in the "lead arsenate without safener" plot by August 22. No mite damage was recorded in the other spray plots although on August 22 mites were found in the calyx ends of apples in the DMT and hexachlorocyclohexane plots.

The value of zinc sulfate as a safener for lead arsenate was again apparent in 1946. The foliage of the trees on this plot was still in excellent condition when compared with that on the "lead arsenate without safener" plot at harvest time. Only about 35 percent of the foliage on the trees sprayed with lead arsenate alone remained on the trees at harvest time.

No undesirable flavor was detected at harvest time in the apples from the hexachlorocyclohexane plots.

Summary

All materials tested except hexachlorocyclohexane gave excellent control of codling moth. The variation in percentage of control obtained was a 4.9 percent spread between the most effective and the least effective treatments.

"Miticidal DDT" proved to be an effective material to control the common red spider mite. Red spider mites did not build up enough to injure foliage in any of the plots except in the one receiving lead arsenate alone. Some trees surrounding the latter plots lost most of their leaves due to red spider mite injury.

The fruit on the trees of the "Black Leaf 155Y" plus summer oil emulsion plot had the heaviest preharvest fruit drop due to chemical injury to the foliage.

Washed samples of apples from trees which had been sprayed with "Deenate 50-W" (50% DDT), when analyzed for this chemical, had a residue of 0.046 grain of DDT per pound of apples, which is 0.003 grain less than the unofficial residue tolerance. Samples of washed and unwashed apples which had been sprayed with DMT, "Miticidal DDT," and "Black Leaf 155"-DDT-summer oil emulsion combinations were below the unofficial residue tolerance of 0.049 grain of DDT per pound of fruit.

Residue analyses indicate the acid wash used to remove arsenic residue from fruit removes little if any DMT or DDT residue. Most of the DMT and DDT residue is removed through handling and weathering processes.

Washed apple samples from plots sprayed with lead arsenate-zinc sulfate-summer oil emulsion, when analyzed for arsenic, had a residue of 0.029 grain of arsenic per pound of fruit; this is 0.004 grain of arsenic more than the official tolerance. Washed apple samples from plots sprayed with lead arsenate alone were below the official tolerance of 0.025 grain of arsenic per pound of fruit.

KENTUCKY

W. A. Price, W. D. Armstrong, and P. O. Ritcher, Kentucky Agricultural Experiment Station, Lexington

Seasonal conditions and codling moth abundance.--There was a heavy carry-over of codling moth worms from the previous season and little winter mortality but the 1946 season, in general, was unfavorable for codling moth development. Moth emergence began unusually early with the first moths appearing at Paducah, April 9, and Lexington, April 29. Due to cold weather during May the emergence period was prolonged. Emergence was heaviest during the second week in June and as a result the first and second broods tended to overlap in July. A third brood failed to develop this season.

Use of DDT.--Many Kentucky growers used DDT in their spray schedules and most of them produced fairly clean crops of apples, due in part to the season. Mite troubles developed in most orchards where DDT was used being most severe in the centers of the trees and on Red Delicious. In eastern Kentucky both the European red mite and the common red spider caused injury while in many western Kentucky orchards injury was caused only by the common red spider.

DDT was used for the first time in the Experiment Station apple orchards at Lexington and gave excellent codling moth control. The schedule used consisted of six first brood cover sprays containing 2 to 4 pounds of lead arsenate plus 6 ounces of actual DDT per 100 gallons followed by three summer sprays of 6 ounces of actual DDT plus 2 pounds of commercial 14 percent nicotine-bentonite, 1 quart summer oil and 2 ounces soybean flour per 100 gallons. Two quarts of summer oil were added to the 3rd, 4th and 5th cover sprays. Fungicides were added as needed.

Late varieties of apples such as Grimes, Red Delicious, Winesap, Stayman and York at harvest were from 82.9 to 93 percent clean in the old station orchard and from 95 to 99.5 percent clean in the young station orchard. Mites became abundant in August necessitating special treatment. An extra spray of 1 pound actual DDT plus 1 1/4 pounds DN-111 was superior to 1 pound actual DDT plus 1 quart summer oil.

MASSACHUSETTS

A. I. Bourne, Massachusetts Agricultural Experiment Station, Amherst.

The Codling Moth Infestation on the whole was lighter than usual throughout Massachusetts during 1946. Much of this is attributed to cold, wet, windy weather during the late spring which provided conditions

very unfavorable to moth activity. On the other hand, in some sections of the State heavy frosts during bloom cut the set of fruit in many orchards with consequent greater concentration of insect attack on fruit which survived. This was in part counteracted by the frequent applications which were necessary to give protection from scab which was unusually prevalent throughout the State.

McIntosh from unsprayed trees in the College blocks showed 50 percent injury from curculio; 66 percent from codling moth and 100 percent infection from scab.

The regular schedule of lead arsenate, generally recommended for the State cut codling moth damage to 16.4 percent, curculio injury to 6.5 percent, and scab to 19 percent.

The application of an emergency spray between the 2nd and 3rd covers, timed to meet the second peak of codling moth emergence, checked damage by that insect to a mere trace (2 apples in 500), and reduced scab injury to 11.6 percent.

The application of fixed nicotine in a mid August spray in 1946 did not furnish any increased protection against either codling moth or scab.

Codling moth attack in the blocks given DDT schedules was so light that little contrast was possible. However, while the regular lead arsenate schedule allowed 2-5 percent damage, plots given a dosage of 1 and 2 pounds DDT (50% wettable powder) in the 2nd cover, emergency cover between 2nd and 3rd covers, and 3rd cover showed practically no damage.

MISSOURI

Lee Jenkins, Missouri Agricultural Experiment Station, Columbia.

The experimental plots at the Gardner-Cardinell Orchard consisted of three single trees, each selected at random.

Three pounds of lead arsenate plus sulfur were used in the calyx and first cover in all plots except 16 and 17, which had no lead arsenate in the calyx application.

The lead arsenate plots were sprayed with 4 pounds lead arsenate plus safener in the 2nd, 3rd, 4th and 5th covers; the 6th, 7th, 8th and 9th covers had 3 pounds lead arsenate plus safener.

The DDT plots had 2 pounds lead arsenate plus 8 ounces of 50 percent DDT in the second cover. All later sprays had 2 pounds of 50 percent DDT per 100 gallons.

All the fixed nicotine plots, including Black Leaf 155X and Black Leaf 155Y, were sprayed with 2 pounds of fixed nicotine starting in the 3rd cover and continuing through the 9th cover. One-half gallon of oil was added to all but the 9th cover, in which the oil was reduced to 1 quart.

Plot 10 - Third, 4th, 5th and 6th covers, 8 pounds bentonite, 1 pint nicotine sulfate, 1/2 gallon summer oil; 7th and 8th covers, bentonite reduced to 4 pounds; 9th cover 2 pounds Black Leaf 155, 1 quart oil.

Plot 11 - Same as Plot 10 except 8 ounces Deenate added in the third through eighth covers. Latex was combined with lead arsenate, DDT, nicotine sulfate and Black Leaf 155 at the rate of 2 pounds of 40 percent Latex per 100 gallons of water starting in the 3rd cover. Latex was discontinued in all but the Black Leaf 155 and the nicotine sulfate combinations after the 6th cover due to foliage injury. Rhothane WP-50 was used at 2 pounds per 100 gallons starting in 3rd cover through 8th cover. H.E. 761 was used at 4 pounds per 100 gallons with 1/2 gallon of oil added in 3rd cover through 8th cover.

The DDT, Rhothane, WP-50 and H.E. 761 plots had only 8 cover sprays as compared to 9 covers in all other plots. All were sprayed on the same schedule except the 9th cover in mid-August was omitted.

JONATHAN PLOTS

Gardner-Cardinell Orchard, 1946

Plot No.	Treatment	% Clean	% Wormy	% Stung	Percent of Leaf Roller
1	Deenate, 2 pounds/100 gallons	79.7	15.25	4.9	8.3
2	Deenate plus Bordeaux	83.0	13.0	3.8	2.4
3	DDT plus Fermate	87.8	7.8	4.3	7.2
4	Latex plus DDT	90.6	5.3	3.9	5.0
5	Fermate and DDT plus Latex	62.7	22.4	14.7	5.9
6	Latex plus Nicotine Sulfate	37.9	53.2	8.7	23.6
7	Latex plus Fixed Nicotine	60.5	32.6	6.8	18.0
8	Latex and DDT @ half strength	76.4	18.9	4.6	4.0
9	Fixed Nicotine and oil	68.8	24.0	6.9	6.5
10	Tank Mix Nicotine and oil	80.7	13.1	6.1	7.8
11	Same as 10 plus 4 ounces DDT	92.1	5.1	2.7	5.1
12	Fixed Nicotine and Oil plus 4 ounces DDT	74.9	17.2	7.8	6.4
13	Fermate, Lead and 4 ounces DDT	65.5	16.9	17.4	3.0
14	Lead 2/3 plus Latex	35.7	37.6	26.6	5.2

Jonathan Plots - Gardner-Cardinell Orchard, 1946 (Continued)

Plot No.	Treatment	% Clean	% Wormy	% Stung	Percent of Leaf Roller
15	Lead 2/3 plus Latex	44.7	30.3	24.9	.4
16	Lead (No Calyx) Nicotine later	59.1	31.0	9.7	13.7
17	(No Calyx) DDT all season	85.7	9.7	4.4	7.8
18	Lead Arsenate all season	52.8	25.0	22.0	2.6
19	DDT all season	75.3	18.9	5.5	5.2
20	Lead and DDT	79.1	11.3	8.7	1.5
21	H E 761 and Oil	86.6	8.3	4.9	1.2
22	Rhothane WP 50	49.3	39.6	10.8	7.1
23	BL 155X and Oil	77.5	17.3	5.0	9.2
24	BL 155Y and Oil	71.6	20.3	8.0	9.9
25	Cytox	78.2	13.2	8.4	3.2
26	Deenate	75.9	14.8	9.1	1.6
27	Lead and Nicotine & Oil (fixed)	60.7	25.6	13.5	2.7
28	DDT and Nicotine & Oil (fixed)	56.9	31.5	11.4	10.0
29	Deenate and Genecide A	64.1	23.5	12.3	9.6

Omilite (Latex) furnished by the B. F. Goodrich Company at 2 pounds of 40 percent Latex per 100 gallons caused considerable loss of foliage when used as a sticker with lead arsenate, DDT or nicotine. Nicotine sulfate with omilite, instead of bentonite, and oil gave only about one-half as much clean fruit as tank-mix nicotine. Black Leaf 155 with omilite was almost as good as with 2 quarts of oil. Four pounds H.E. 761 (from Rohm and Haas) in combination with 2 quarts of oil gave codling moth control about equal to DDT, but caused severe russeting of the fruit. Neither Fermate at 1 pound per 100 gallons all season nor 4-6-100 Bordeaux in the sixth, seventh and eighth covers caused any noticeable reduction in codling moth control when combined with DDT.

Lead arsenate, 2 pounds plus 8 ounces of Deenate, gave codling moth control nearly equal to 2 pounds of Deenate. The addition of Fermate to the above combination reduced codling moth control but was still some better than lead arsenate alone. The addition of 8 ounces of Deenate to Black Leaf 155 and oil did not improve codling moth control.

The addition of 8 ounces of Deenate to the tank-mix nicotine spray increased clean fruit 12 percent above tank-mix nicotine alone.

Black Leaf 155X (by Tobacco By-Products Corporation) and oil was slightly better than 155 and oil.

Black Leaf 155Y and oil gave about the same control as Black Leaf 155 and oil.

There was more oil spotting of the fruit in all cases where oil and DDT were combined than the same combination without DDT.

There was a marked increase in the damage from red banded leaf rollers in some orchards where the full DDT program was used. There was also a tendency toward higher populations of red spiders, red mites (in Northwest Missouri) and woolly aphids.

NEW JERSEY

B. F. Driggers, New Jersey Agricultural Experiment Station, New Brunswick.

Codling Moth and Red Mite Control on Apples

Several new materials which had shown promise as a control for codling moth, including several DDT preparations, a plant product "Ryanex," two Rohm and Haas products known respectively as HE 761 and Rothane W.P. 50 and a du Pont product, Di (methoxyphenyl) trichloroethane, were tested on Delicious and Rome at Glassboro in comparison with the two standard New Jersey schedules for apple orchards in southern New Jersey. One of these, a wash schedule, called for the use of lead arsenate-oil-nicotine and the other, a non-wash schedule, called for the use of oil-fixed nicotine. Two extra plots were included in which to test DN-111 and "Genicide," a General Chemical Company trade named product for xanthone, in combination with DDT for mite control. Summer oil was also used for mite control. A straight DDT sprayed plot was included to serve as a "check" for the DDT-mite control combinations.

Each plot was two rows wide and made up of 14 Delicious trees and 6 Rome trees. Plot treatments were begun at the second cover spray. Previous to the second cover spray the trees had received a dormant spray of Elgetol for aphid control, a prepink spray of commercial lime sulfur and a pink spray of wettable sulfur for disease control. A petal fall spray of lead arsenate plus wettable sulfur was applied followed by a first cover spray of lead arsenate and Fermate. No dormant oil spray for mite control was used on these trees.

Ten days after the first cover spray a second cover spray was applied on May 16th and 17th. The individual plot treatments applied at that time are set forth in Table 1.

Table 1. Codling moth and mite control plots on Delicious and Romes. Materials used in second cover spray applied May 16 and 17.

Plot No.	Treatment (Materials in 100 Gallons of Water)1/
1	Black Leaf 155 1-1/2 lb., 83% oil 2 quarts
2	Black Leaf 155X 2/ 1-1/2 lb., 83% oil 2 quarts
3	Black Leaf 155Y 3/ 1-1/2 lb., 83% oil 2 quarts
4	Lead arsenate 3 lb., 83% oil 3-1/3 quarts, Black Leaf 40 3/4 pt.
5	Cytox DDT 2 lb., lead arsenate 3 lb.
6	Cytox DDT 2 lb., lead arsenate 3 lb.
7	Cytox DDT 2 lb., lead arsenate 3 lb.
8	Cytox DDT 2 lb., lead arsenate 3 lb.
9	90% DDT 1.1 lb., lead arsenate 3 lb.
10	DDT Emulsion (25%) 1 qt., lead arsenate 3 lb.
11	Ryanex 6 lb.
12	Di (methoxyphenyl) trichloroethane 2 lb., lead arsenate 3 lb.
13	HE-761 1-1/2 lb., lead arsenate 3 lb., oil 1 quart.
14	Rothane W.P.-50 2 lb., lead arsenate 3 lb.

1/ Fermate, 1 pound-100 gallons, used with all treatments.

2/ Black Leaf 155X contains 12% fixed nicotine and 7% technical DDT.

3/ Black Leaf 155Y contains 12% water soluble nicotine and 7% DDT.

In Table 1 it will be noted that Fermate was used in all treatments as the fungicide in the second cover spray. It had been used by the grower also in the first cover spray and was used again in the third cover spray. Thus an excellent opportunity was afforded to study the compatibility of Fermate with the various spray combinations, especially DDT-oil on which there were reports of injury on certain apple varieties where a combination of oil-DDT-Fermate was used. No injury from the use of Fermate with any of the combinations was noted.

A third cover spray was applied on the various plots on May 29th and 30th. The same materials were used with the following exceptions: (1) On plot 6 the Cytox DDT was used at 1 pound to 100 gallons and oil was added (83% emulsion) at the rate of 3 1/2 quarts to 100 gallons. (2) Genicide 1 pound to 100 gallons was added on plot 7 and DN-111 1 1/4 pounds was added on plot 8. (3) On plot 11 the Ryanex was reduced to 3 pounds per 100 gallons. (4) Lead arsenate was omitted in plots 5, 6, 7, 8, 9, 10, 12, 13 and 14.

Apple scab continued to be a threat and for this reason a special spray of Coposil 1 1/2 pounds plus lime 1 1/3 pounds to 100 gallons of water was applied on all plots on June 5th between the third and fourth cover sprays.

The special Coposil-lime spray of June 5th was followed by the fourth cover spray on June 10 and 11. The same materials and proportions were used in the various plots on the fourth cover spray as were used in the third cover spray.

Since scab was still a problem in the plots following the fourth cover spray a second fungicide spray of copper sulfate 1 pound plus lime 4 pounds to 100 gallons was applied on June 20-21 to all the plots.

On June 24 and 25 a fifth and final first brood cover spray was applied on all plots except plots 5 and 9. By the time the fifth cover spray was due the mites on these plots had built up to such a point that they were bronzing the trees. Therefore, these plots were abandoned and the trees used to set up plots for testing various mite control combinations. The plots were sprayed at the fifth cover spray the same as the fourth except on plot 4 lead arsenate was omitted and in its place Black Leaf 155 1-1/2 pounds was used. To this was added Black Leaf 40 3/4 pint and 83 percent oil emulsion 3 1/3 quarts to 100 gallons.

Around the middle of July, counts were made of codling moth injury at the end of first brood. One hundred apples were examined at random on each of several trees on each variety in the different plots. The results of these counts are set forth in Table 2.

Table 2. Codling moth injury to end of first brood in plots sprayed with different materials. A thousand apples examined on Delicious and 500 on Romes in each plot. 1/

Plot No.	Treatments 2/	% Codling Moth		Wormy Drops per Tree	
		Delicious	Rome	Delicious	Rome
1	Black Leaf 155-oil	1.3	0.8	13	6
2	Black Leaf 155X-oil	0.6	0.0	6	4.5
3	Black Leaf 155Y-oil	1.7	0.2	5	2.0
4	Lead Arsenate-oil-nicotine	0.8	0.0	.2	1.0
5	1 lb. DDT	0.2	0.0	1	2.0
6	1/2 lb. DDT-oil	0.3	0.0	.3	.8
7	1 lb. DDT-Genicide	0.0	0.0	1	.5
8	1 lb. DDT-DN-111	0.0	0.0	2	1.0
9	1 lb. 90% DDT	0.1	0.0	2	.7
10	1/2 lb. DDT in Emulsion	0.3	0.0	2	2.5
11	Ryanex	1.1	0.4	6	3.0
12	Di Methoxy DDT	0.9	0.6	7	-
13	HE-761-oil	1.1	-	14	-
14	Rothane W.P.-50	0.2	-	1	-

1/ Mr. Merrill assisted in taking these records.

2/ See Table 1 for details of plot treatments.

The counts of codling moth injury to the fruit on the tree showed a very low percentage of codling moth injury, being less than 2 percent in all cases, including the standard treatments of oil-nicotine and oil-lead-nicotine. In an effort to show some difference in codling moth control between treatments the wormy drops on each of five trees in the Delicious and each of five trees in the Romes in each plot were collected during the last half of July. The results are recorded as wormy drops per tree in the last two columns in Table 2 and show further that codling moth injury was low in all plots.

Besides the plots at Glassboro, codling moth control was checked in a series of plots in the Seabrook Farms Orchard at Bridgeton. Here, three varieties, Golden Delicious, Red Delicious and Winesap were sprayed with DDT in comparison with the regular recommendation of the experiment station and with Rothane W.P. 50 and HE 761. Another plot was sprayed with a split schedule of DDT followed by oil-lead arsenate-nicotine. A total of 7000 apples were examined in the different varieties receiving the different treatments. Only three stung apples were found in the entire 7000 examined which, of course, means that no significant differences occurred between the different treatments.

The Seabrook treatments did bring out one interesting difference in treatment. The Rothane caused severe injury to foliage. It took the form of a yellowing of the leaves followed by defoliation. This type of injury was particularly noticeable on the younger leaves at the tip and on suckers inside the tree.

European Red Mite Control

The control of mites during and following the use of DDT was an important consideration in the apple spraying experiments at Glassboro. Previous experiments had shown that the use of DDT was likely to be followed by a sharp increase in mite populations. In the plot set-up summer oil, DN-111, and Xanthone (Genicide) were tested with DDT for the control of mites. As previously related, the different plot treatments were begun at the second cover spray on May 16 and 17. The mite control materials were not added until the third cover spray which was applied May 29 and 30. Two additional cover sprays were applied on June 10-11 and June 24-25 in which mite control materials were added to the DDT.

Mite counts were made on the different plots on June 14 following the fourth cover spray and at intervals thereafter. The results from the Delicious variety are given in Table 3.

Table 3. European red mite adults and nymphs on Delicious apples sprayed with different spray mixtures.

Plot No.	Treatment 1/	Number of Mites per 100 Leaves on: 6/14	6/19	6/27	7/3	7/17
1	Black Leaf 155-oil	490	930	730	3800	1711
2	Black Leaf 155X-oil	510	580	1110	5340	1470
3	Black Leaf 155Y-oil	310	250	800	5040	1110
4	Lead arsenate-oil-nicotine	130	230	510	2180	710
5	1 lb. DDT	2320	2420	--	--	--
6	1/2 lb. DDT-oil	260	370	410	2030	520
7	1 lb. DDT-Genicide	450	300	40	2860	10
8	1 lb. DDT-DN-111	460	450	1080	4980	570
9	1 lb. DDT (90%)	2280	2810	--	--	--
10	1/2 lb. DDT (Emulsion)	1090	690	1780	3560	1040
11	Ryanex	1770	1160	4100	4380	--
12	Di Methoxy DDT	2070	1970	1740	2630	140
13	HE 761-oil	750	770	2160	2550	460
14	Rothane W.P. 50	400	470	2040	3320	660

1/ See Table 1 and context for details of plot treatments.

On June 14 the counts showed that the DDT plots (5 and 9, Table 3) had a much heavier mite population than other plots which were not sprayed with DDT or were sprayed with DDT plus mite killing materials. A second check of mites on June 19 showed a somewhat higher mite population on most of the plots, however, the DDT sprayed plots were much more heavily infested than the non-DDT sprayed plots or the DDT plots containing mite killing agents.

By the time the fifth cover spray was due to be applied on June 24, the trees in plots 5 and 9 were showing bronzing from the heavy mite populations. These two plots were abandoned and the trees used to test materials designed to control, or at least cut down, the heavy mite population. The remainder of the plots were sprayed as scheduled with the fifth cover spray on June 24-25. Mite counts on June 27 (Table 3) showed mites present on all plots in medium to heavy numbers except on the Xanthone-DDT plot (Plot 7). This plot showed less than 40 mites per 100 leaves whereas all the other plots were running several hundred to several thousand mites per 100 leaves.

Following the fifth and last first brood cover spray on June 24-25, no additional spraying was done for the next two weeks. On July 9 a mite count was made on all the plots (Table 3) and all the plots showed heavy mite populations. Some of the trees were beginning to show bronzing typical of red mite injury. Since several hundred trees were involved in the plot set up it was necessary to do something to reduce the mite populations on the plots to avoid financial loss to the grower. Accordingly, on July 12, plots 1, 2, 3, 4, 6, 11, 12, 13 and 14 were sprayed with 83 percent summer oil emulsion six quarts to 100 gallons water. Plots 7 and 8 were sprayed at the same time with Genicide (1 pound to 100 gallons) and DN-111 (1 1/4 pounds to 100 gallons). On July 17 mite counts were again made on the plots with the results shown in the last column of Table 3. These data show that mite populations were greatly reduced following the spraying with oil, Genicide and DN-111 on July 12 but a complete clean up was not obtained.

Efforts to Clean Up Heavy Mite Populations

It will be recalled that mite populations had built up so heavily on the DDT sprayed plots 5 and 9 by June 25, when the fifth and last first brood cover spray was due, that these plots were abandoned and the trees used to test mite clean up sprays. Six plots consisting of two Delicious and two Rome trees were laid out. These special plots, which had been sprayed with DDT (1 pound actual) on May 16, May 29, and June 10, were sprayed as follows on June 26: Plot 1, 1 pound 50 percent DDT plus 6 quarts 83 percent oil; Plot 2, 2 pounds 50 percent DDT plus 1 1/4 pounds DN-111; Plot 3, 2 pounds 50 percent DDT plus 1 pound Genicide plus 1/4 pound Genifilm A; Plot 4, 2 pounds 50 percent DDT plus 2/3 pound DN-dry mix No. 1; Plot 5, 2 pounds 50 percent DDT plus 1 pound Genicide, 1/4 pound Genifilm A, 3 quarts kerosene; Plot 6, 2 pounds 50 percent DDT (check). One week later a second application was made with the different mite killing materials with the DDT omitted. In making the two spray applications a single nozzle gun was used and the tree sprayed from inside and outside. Before these clean up sprays were applied the trees were found to be heavily infested with nymphs and adults (50 to 200 per leaf). Following the two sprays a check of live mites was made using binoculars. Ten leaves per tree per plot were examined. The data from these counts are set forth in Table 4.

Table 4. European red mite counts on plots sprayed twice with different mite killing materials. Plots sprayed June 26 and July 3, mite counts made July 9.

Plot No.	Treatment	Number of Live Mites per 100 Leaves Delicious	Rome
1	6 qt. 83% oil	430	385
2	1 1/4 lb. DN-111	575	1,575
3	1 lb. Genicide	985	1,410
4	2/3 lb. DN-Dry Mix	505	420
5	1 lb. Genicide + Kerosene	595	350
6	Check	12,550	10,845

The data in Table 4 shows that under extremely heavy mite populations none of the mite killing materials available gave a complete clean up of mites. Even after two thorough spray applications, spaced a week apart, the mites were running from about 3 or 4 to 14 or 15 per leaf a week after the second application. This was enough of a population to enable the mites to increase again to damaging number in a few weeks. It was necessary to spray the plots again on July 31 using the same materials as used in the second spray of July 3.

Our experience with European red mite control this past summer leads the writer to the conclusion that under heavy mite populations it is practically impossible to clean up a heavy infestation with presently available materials (summer oil, DN-111, DN-Dry Mix and Genicide). It should be pointed out that no dormant or delayed dormant oil was applied on these trees and the mite populations were fairly heavy before the mite killing materials were included at the third cover. Furthermore, one of the varieties used in the tests (Red Delicious) appears to be especially susceptible to European red mite. It should be further noted, in viewing the performance of DN-111, that copper-lime sprays were used on all the plots between the third and fourth and between the fourth and fifth cover sprays. Lime is known to reduce the effectiveness of DN-111.

Late Season Tests with Hexaethyl Tetraphosphate

During August an opportunity was afforded to test several brands of the new chemical, hexaethyl tetraphosphate against mites in an orchard at Richwood. A California Spray-Chemical Corporation product "Vapatone" was available and in addition experimental samples from the Niagara Sprayer Company and the General Chemical Company. The "Vapatone" of California Spray-Chemical Corporation was used at 1 pint and 2 pints to 100 gallons water. The two other brands were used at strength equivalent to 1 pint of the Vapatone. DN-111 was used at 1 1/4 pounds to 100 gallons for comparison and unsprayed trees were available for checks. Live mites were determined one, five and six days following the treatments. Results are set forth in table 5.

Table 5. Mite Control with Hexaethyl Tetraphosphate

Plot No.	Treatment 1/	No. Live Mites/100 Leaves 1 Day	5 Days	6 Days
1	1 pt. Vapatone	80	1340	2120
2	2 pt. Vapatone	25	1090	3400
3	1 pt. Niagara	80	1290	1960
4	1 pt. Gen. Chem.	25	1920	3300
5	1 1/4 lb. DN-111	80	40	180
6	Check	3800	2640	6280

1/ Amounts per 100 gallons.

The data in Table 5 show that hexaethyl tetraphosphate is very effective in killing mites. However, it appears to have little or no effect on the eggs. After five or six days the mite populations, mostly nymphs, were heavy in the hexaethyl tetraphosphate sprayed plots. The DN-111, however, showed some residual action since mites were much less on this plot after five and six days than on the other plots. No injury was observed from the one spray of hexaethyl tetraphosphate.

DDT Residue at Harvest

At the end of first brood codling moth attack (Table 2) it was evident that codling moth would not be a serious problem during second brood. However, it was decided to apply one second brood spray on one-half of each plot in order to obtain data on DDT residue at harvest. Plots 2, 3, 4, 6, 7, 8 and 10 were divided in half and one-half sprayed on August 2-3 with the spray materials used in the fifth cover spray. On September 1 samples of apples (Delicious variety) were collected from the plots and submitted to Dr. A. C. McLean of the Spray Residue Department who analyzed them for DDT using the modified Gunther method. The data, expressed as grains of DDT per pound of fruit are set forth in Table 6.

Table 6. Amount of DDT at harvest on Red Delicious receiving different spray treatments.

Plot No.	Treatment	Grain per Pound of Fruit
2A	B. L. 155X 1st and 2nd brood	.018
2B	B. L. 155X 1st brood only	.012
3A	B. L. 155Y 1st and 2nd brood	.022
3B	L. L. 155Y 1st brood only	.014
4A	L. A.-oil-nic. 1st and 2nd brood	.046 1/
4B	L. A.-oil-nic. 1st brood only	.040 1/
6A	DDT-oil 1st and 2nd brood	.034
6B	DDT-oil 1st brood only	.019
7A	DDT-Genicide 1st and 2nd brood	.026
7B	DDT-Genicide 1st brood only	.017
8A	DDT-DN-111 1st and 2nd brood	.030
8B	DDT-DN-111 1st brood only	.022
10A	DDT Emulsion 1st and 2nd brood	.042
10B	DDT Emulsion 1st brood only	.028

1/ Lead analysis.

The data in Table 6 show that in every case the addition of one second brood spray following four first brood sprays increased the DDT residue load at harvest. However, four first brood sprays plus a second brood spray applied approximately 40 days before harvest showed residues well below the tentative tolerance of .05 grains DDT per pound of fruit.

In another orchard where no DDT was used during first brood but a single spray of 2 pounds 50 percent wettable DDT powder was applied August 5, fruit harvested forty days later showed DDT residues of .021, .027, .038 and .030 grains per pound on the varieties Red Delicious, Golden Delicious, Rome and Staymans. It appears, therefore, that the time of application in relation to date of harvest is a more important factor in determining DDT residue at harvest than the number of applications of DDT.

NEW YORK

S. W. Harman, New York Agricultural Experiment Station, Geneva.

Seasonal Conditions

Generally speaking little difficulty was experienced in combatting the codling moth in western New York apple orchards this past season. The first brood of worms was very slow in making its appearance, and relatively little damage developed. The second brood was much more active especially where there had been poor spraying early in the season. A small carry-over of worms, the result of an extremely light crop of fruit in 1945; the presence of considerable disease in the hibernating larvae; unfavorable early season conditions for insect activity; and the general use of DDT; apparently were all contributing factors that may partly explain the unusually light attack by the codling moth experienced this past season.

Control Tests

Figures on codling moth control are given in the following tables. A total of five summer applications were made, three for the first brood worms on June 17, July 1 and 11, and two for the second brood on August 6 and 21. Sprays were used at the rate of approximately one gallon per bushel of fruit per application. Dusts were applied to two sides of the trees using from 2-1/2 to 3 pounds per tree per application.

Orchard No. 1

Materials in 100 Gallons	Worms in 100 Apples
Lead arsenate 3 lb.	15.8
DDT, McL. G. K. & Co. Multicide 75W, 1-1/3 lb.	1.1
DDT (technical) 1 lb.; Benzene 1 qt.; B-1956 2 oz.	1.1
DDT, DuPont 50% wettable powder, 2 lb.	0.3
Checks	73.5; 43.8; 37.1

Orchard No. 2

Materials in 100 Gallons	Worms in 100 Apples
DDT, DuPont 50% wettable powder, 2 lb.	0.3
DDT (technical) 1 lb.; Benzene 1 qt.; B-1956 2 oz.	0.1
DDT, DuPont Miticidal, 5 lb.	0.7
Lead arsenate - 3 lb.	9.8
Rothane - 2 lb.	1.2
Black Leaf 155X - 3 lb.	4.6
Black Leaf 155Y - 3 lb.	1.8
DDT, Tobacco By-Products Corporation 25%, 4 lb.	1.2
Benzene Hexachloride, 5 gamma, 3-1/2 lb.	16.5
Checks	41.4; 43.8; 25.0; 70.5; 25.1; 33.1; 38.7; 35.4

Orchard No. 3

Dust	Worms in 100 Apples
5% DDT dust, 5 applications	0.9
5% DDT dust, 5 applications	0.3
5% DDT dust, 5 applications	0.4
Checks	37.2; 14.8; 8.9

These data indicate that DDT sprays, at the rate of one pound of actual DDT in 100 gallons, were all about equally effective against the codling moth. Also, that DDT was noticeably superior to lead arsenate.

Five percent DDT dusts gave promising control of the codling moth. However, the orchard in which the dust tests were made was not heavily infested.

Spray Residue

A full schedule of five DDT summer sprays, using one pound actual DDT in 100 gallons, and leaving an interval of approximately one month between the final spray and harvest, met present tolerance requirements. Figures on residue analyses indicated that the late season applications were those most important in building spray deposit, and that handling incident to harvesting removed considerable residue. Residues from DDT dust treatments were much lighter than those on sprayed fruit.

Seasonal conditions were favorable for the European red mite, *Paratetranychus pilosus* (C & F), and it developed into problem numbers in most orchards. Apple growers found it necessary to spray at least once for this mite.

The red-banded leaf roller, *Argyrotaenia velutinana* (Wlkr.), was noticeably on the increase in all apple producing sections. A full schedule of either DDT or lead arsenate sprays for both broods of codling moth caterpillars appeared to hold this leaf roller in check. Where abbreviated schedules were practiced, fruit was damaged up to 20 percent of the crop in a few instances. In general, the injury was considerably below this figure.

OHIO

C. R. Cutright, Ohio Agricultural Experiment Station, Wooster.

Temperatures for May and June were below normal and the season generally was unfavorable for codling moth. For example, in 1944, a schedule of eight lead arsenate sprays plus oil in three first-brood covers permitted 72 percent codling moth-injured fruits. This year the same schedule in the same orchard produced only 16 percent injured fruits.

Over 30 different spray schedules for codling moth control were tested at different points in Ohio. Practically all experimental schedules contained DDT as the principal insecticide. The results of these trials may be summarized as follows:

1. Lead arsenate was ineffective when compared to DDT.

2. DDT schedules started in the first cover were not superior to those started in the second cover. However, DDT started in the third cover was not as effective as when started in the first or second cover spray.

3. DDT used as low as 1/2 pound actual, when trees were thoroughly sprayed, was fairly effective. (Growers using 3/4 pound actual, with one exception, were satisfied with this dosage).

4. A schedule of DDT 2 pounds, 50 percent, in three first-brood covers followed by three applications of Black Leaf 40, 1/2 pint, oil 1/2 gallon, Mississippi Bentonite 4 pounds, and DDT actual 1/4 pound gave excellent control of both codling moth and mites.

5. All season applications (four or more) of DDT--oil combinations in almost every instance produced injury to foliage and dull-finished fruit.

6. All DDT plots were seriously infested by European red mite unless acaricides were used.

7. Applications of dormant oil preceding DDT schedules delayed mite injury from four to six weeks. Some growers who used dormant oil followed by DDT escaped mite injury.

8. Summer dinitro was generally the most successful acaricide for summer use with DDT.

9. Some damage by red-banded leaf roller appeared in one DDT-sprayed orchard.

The use of DDT in codling moth problem orchards has been so successful that it will be quite difficult to find a heavily infested Ohio orchard for experimental use in 1947. Therefore, much of the prior emphasis on codling moth is being shifted to work with the European red mite.

OKLAHOMA

F. E. Whitehead, Oklahoma Agricultural Experiment Station, Stillwater.

During the season of 1946 heavy infestations of codling moths and severe injury was experienced in Central and Western Oklahoma. This appears to have been due to a heavy carry-over from 1945 and weather conditions favorable to codling moths in 1946. An unusually early spring

resulted in codling moths beginning their emergence nearly two weeks earlier than normal. As a result, many orchards were not sprayed early enough for the beginning of the first brood. Also, much cool weather intervened after emergence started resulting in emergence lasting over a very long period necessitating two to three sprays for the first brood. Many growers failed to do this with the result that a high percentage of the overwintering brood entered the apples. This followed by high summer temperatures resulted in high injury.

In Eastern Oklahoma as a result of a very light crop in 1945 the carry-over was small and much less injury occurred.

In Central Oklahoma heavy populations of the common red spider (Tetranychus bimaculatus Harvey) have invariably followed when DDT has been applied throughout the season.

Work conducted during the 1946 season was directed toward developing a spray program in which DDT may be used to control codling moth and at the same time prevent mites from occurring in injurious numbers.

In the experiment station orchard at Perkins, the rows of trees running north and south are of the same varieties. Four rows running East and West and therefore containing all varieties were sprayed regularly, beginning with the first cover spray, with DDT (50%) at the rate of 2 pounds per 100 gallons of water. One and one fourth pounds of DN-111 (Dow Chemical Company) was added for each spraying of Row 1. The others were sprayed with DDT only until mites appeared and then sprayed one, two, or three times, whichever was necessary to control the mites. The materials used other than DN-111 were azobenzene, hexachlorocyclohexane, Hydroxy Pentamethyl flavan (DuPont), and Di (P-phenyl) methyl carbinole (D.M.C.)(Sherwin-Williams). In all cases, dilutions were made on the basis of active ingredients contained in the materials used rather than on the amount or weight of the material.

In another experiment, 11 pairs of trees of the same variety (Jonathan and Winesap) were sprayed. One of each pair was sprayed with DDT, the other with a mixture of DDT and varying amounts of the miticides. Also, some young non-bearing trees were sprayed with DDT and when mite populations developed, they were used as test trees for determining the toxicity of the miticides tested.

Mite counts were taken immediately before spraying, the first or second day after spraying and at varying intervals following spraying for 30 days. In taking these counts, 25 to 50 leaves were collected from different parts of the tree. The mites from these leaves were brushed by hand onto paper disks mounted on a whirling turntable. The disks had previously been marked so that each of four areas contained 10 degrees or 1/36 of the area of the circle. Therefore, the four

areas combined constituted 1/9 of the total area of the circle. The disks were painted lightly with shellac just previous to brushing the mites on them to prevent movement of the mites. It was found that in spite of the shellac, many mites were still able to crawl about and therefore following the brushing the disks were sprayed lightly with carbon tetrachloride which stopped all crawling. The disks were then placed on the stage of a wide field binocular microscope and all mites in the marked areas counted. Since the four marked areas contained 1/9 of the total area, the number of mites counted was multiplied by nine and this number divided by the number of leaves brushed obtained the average number of mites per leaf.

In analyzing the data thus obtained, it was found that such great variations occurred in mite populations during the intervals between counts on both the check and sprayed trees, that significant differences in the killing ability of the materials used failed to appear. All of the materials used resulted in high mortalities of the mite populations immediately following the spraying but in most cases they soon built back up to a high level.

Table 1. Control of Spider Mites (Tetranychus bimaculatus Harvey)

Material	Amount of Active Ingredients lb/100 gal.	Degree (Percent) of Control After		
		10 Days	20 Days	30 Days
Azobenzene	1/2	0	0	0
	1	0	0	0
	2	0	0	0
Hexachlorocyclohexane	1/2	0	0	0
	1	31	2.6	0
	2	32	0	0
Hydroxy Pentamethyl flavan	1/2	0	0	0
	1	0	0	0
	2	10	0	0
DN-111	1/4	93	87	67
Di (P-phenyl) methyl carbinol	1/2	97	95	85
	1	94	95	98

The data in Table 1, however, show that with two materials (Di(P-phenyl) methyl carbinole and DN-111) control remained effective for a period of at least 30 days.

The instructions on the packages of DN-111 state that this material should not be used with arsenate of lead or alone when the temperature is 90° F. or higher or when such temperatures are expected within a 24-hour period. It is interesting to note that in 1946 at Stillwater there were no days at all during the period mite populations were high that the temperature did not exceed 90°. However, observations made in 1945 indicated that burning did not always follow applications of DN-111 at the higher temperatures and therefore spraying with this material was continued without regard to the temperature. On July 25, the temperature was 100° at the time the spray was applied. Despite these high temperatures, only very slight indications of burning were observed in any case and in most cases no burning at all could be detected.

Another point of much interest brought out in these experiments was that DN-111 when used with DDT throughout the season appeared to adversely affect the ability of DDT to prevent codling moth larvae from entering the fruit. It was noticed throughout the latter part of the season that the foliage on the row thus treated was in better condition than in the other plots, but as the season progressed, it was also noticed that the fruit on this row appeared more wormy than elsewhere. At harvest, infestation counts were made in all plots. As before stated, there was a very light crop, many of the trees bearing no fruit at all and many of the remaining trees having very light crops. As a result, the number of fruits counted on some plots was too small to be significant. Therefore, the data was compiled into but three groups as shown in Table 2.

Table 2. Percentage of Apples Infested with Codling Moth Larvae

Treatment	Infestation
Sprayed throughout season with DDT and once or twice with miticides	31
Sprayed throughout season with arsenate of lead	53
Sprayed throughout season with DDT and DN-111	69

It is not thought that the data is sufficient from which to draw conclusions but it gives definite indications that DN-111 as used in this particular experiment counteracts the effectiveness of DDT.

The high infestation in the DDT sprayed trees may indicate that DDT looses its effectiveness rather rapidly during extremely hot weather such as occurred during the latter part of July and August and therefore more frequent applications may be needed in hot weather.

OREGON

L. G. Gentner, Southern Oregon Branch Experiment Station, Talent.

Weather conditions were favorable for higher egg deposition than normal by moths developing from overwintering larvae. This made it more difficult than usual to obtain satisfactory control with lead arsenate. A calyx and six cover sprays were recommended for apples and late pear varieties, and a calyx and five cover sprays for Bartlett pears. The fruit was harvested somewhat later than normal.

Tests for codling moth control were carried on in a commercial Bartlett orchard, with some Bosc trees intermingled. Each plot consisted of eight trees--four random replicates of two trees each. All of the fruit, both from the trees and on the ground, was examined for worm injury from all trees in each plot. Standard plots received a calyx and five cover sprays. In most of the DDT plots some of the applications were omitted. Dates of application were as follows: Calyx, April 30; first cover, May 24; second cover, June 4-6; third cover, June 19; fourth cover, July 17; fifth cover, August 8; sixth cover (Bosc), August 25.

Tests were also carried on in the station orchard on Anjou, Bartlett, Bosc, Comice, and Winter Nelis pear varieties. The trees are planted in blocks of six rows of five trees each for every variety. All of the trees received a calyx application of 3 pounds lead arsenate, 4 ounces deposit builder, and 1 quart stove oil. The west 2 rows of each variety received 4 cover sprays of water dispersible DDT at the rate of 1/2 pound of actual DDT per 100 gallons of spray. The east 2 rows received 5 to 6 cover sprays of the standard lead arsenate schedule, depending upon the variety. The middle 2 rows received varying schedules. Results were based upon the examination of the fruit from two trees for each treatment. Dates of application: Calyx, April 29-May 3; first cover, May 17-23; second cover, June 1-7; third cover, June 24-28; fourth cover, July 23-29; fifth cover, August 10-15; sixth cover, August 22-23.

Sprays were applied with a Bean portable sprayer at a pressure of 400 to 450 pounds at the pump, using two leads of hose with single spray guns with 7/64 inch openings in the discs.

Control by Insecticides

Lead arsenate used at the rate of 3 pounds in 100 gallons in combination with a deposit builder and stove oil gave the poorest control of any materials tested. Very little lead arsenate will be used in the Rogue River Valley in 1947, because it is becoming increasingly more difficult to control codling moth with this material and because of the arsenical residue which remains in the soil.

Both natural and synthetic cryolite used in the cover sprays at the rate of 3 pounds in 100 gallons in combination with 4 ounces of Cryolite Sticker Spreader or Colloidal 77 and 1 quart of stove oil gave much better control than lead arsenate.

Control in Commercial Bartlett Orchard

Plot and (1)(2) Material	% Calyx Injured	% Side Injured	Total % Wormy	Av. No. Fruits Per Tree
# 1 - Chipman lead arsenate,77, (3) stove oil in all sprays(Check)	2.3	10.5	12.8	1,256
# 2 - Chipman lead arsenate,Z-1, in all sprays	5.1	14.4	19.5	1,585
#3 - Astringent lead arsenate,Multi-Film,stove oil in all sprays	2.5	8.6	11.1	1,378
# 4 - No calyx; Genitox(DDT),77, stove oil in 1,3,5	0.4	1.0	1.4	1,199
# 5 - L.ars.,77,stove oil in calyx; Genitox,77,st. oil in 1,3,5	0.4	1.2	1.6	1,305
# 6 - L.ars.,77,stove oil in calyx; Alorco,CSS,stove oil in covers	0.5	1.5	2.0	1,119
# 7 - L.ars.,77,stove oil in calyx; Kryocide,CSS,stove oil in covers	1.0	3.6	4.6	1,421
# 8 - L.ars.,77,stove oil in calyx; Genicide,77,st.oil in covers	2.6	8.1	10.7	1,304
# 9 - L.ars.,77,stove oil in calyx; micr. phenothiazine,Z-1 in covers	0.7	1.3	2.0	1,027
#10 - L.ars.,77,stove oil in calyx; Deenate 50W in 1,2,4	0.1	1.8	1.9	1,369
#11 - L.ars.,77,stove oil in calyx; Chipman DDT,77,stove oil in all covers	0.1	0.2	0.3	1,272
#12 - L.ars.,77,stove oil in calyx; Chipman DDT,77,stove oil in 1,2,3,5	0.2	0.7	0.9	1,531
#13(Bosc) - L.ars.,77,stove oil calyx; Genicide,77,stove oil in 1,6; Genicide A,77,stove oil in 2-5	0.01	0.03	0.04	919
#14(Bosc) - L.ars.,77,stove oil in all sprays	0.8	3.9	4.7	903

(1) Lead arsenate, Alorco (synthetic cryolite), and Kryocide (natural cryolite) were used at the rate of 3 pounds in 100 gallons; Genicide (xanthone) and Genicide A (xanthone and DDT), 2 pounds; micronized phenothiazine, 1½ pounds, Genitox (DDT), Deenate 50W, and Chipman DDT were used at the rate of ½ pound actual DDT per 100 gallons, except Chipman DDT in the first three covers in Plot 11, at ¾ pound DDT; Colloidal 77, Multi-Film, and CSS (Cryolite Sticker Spreader), 4 ounces; Z-1 deposit builder, 1/3 pound; stove oil, 1 quart.

(2) ¾ pound DN-111 and 1/3 pound Z-1 were substituted for the usual deposit builders in all plots except 8 and 13, for spider mite control.

(3) Chipman lead arsenate was used in all plots unless otherwise noted.

Control in Station Orchard

Variety	Material and (1) No. of Covers	% Calyx Injured	% Side Injured	Total % Wormy	Av. No. Fruits Per Tree
Anjou	DDT, 4 covers	0.0	0.4	0.4	1,437
	Genicide A, 4 covers	0.0	0.2	0.2	1,668
	Lead ars., 6 covers	0.0	10.1	10.1	1,600
Bartlett	DDT, 4 covers	0.1	0.1	0.2	1,658
	DDT, 1 cover, l. ars.,3	2.2	3.4	5.6	2,118
	Lead ars., 5 covers	8.0	27.3	35.3	2,411
Bosc	DDT, 4 covers	0.0	0.6	0.6	707
	Lead ars., 6 covers	0.9	13.4	14.3	1,015
Comice	DDT, 4 covers	0.0	0.3	0.3	965
	Lead ars., 6 covers	3.9	4.2	8.1	1,291

(1) A calyx spray of 3 pounds Astringent lead arsenate, 4 ounces Multi-Film, and 1 quart stove oil was applied to all trees in the entire block. This same combination was used in all lead arsenate cover sprays except the 3rd, 4th, and 5th, in which a combination of $\frac{3}{4}$ pound DN-111 and 1/3 pound Z-1, or some other miticide, was substituted for the Multi-Film and stove oil. In the DDT cover sprays a combination of 1 pound Genitox (0.5 pound DDT), 4 ounces Colloidal 77, and 1 quart stove oil was used, except in the 3rd, 4th, and 5th, in which a combination of $\frac{3}{4}$ pound DN-111 and 1/3 pound Z-1 was substituted for Colloidal 77 and stove oil for mite control. Genicide A (xanthone and DDT) was used at the rate of 2 pounds with 4 ounces Colloidal 77 and 1 quart stove oil.

Micronized phenothiazine (Plot 9), at the rate of $1\frac{1}{2}$ pounds with 1/3 pound Z-1 deposit builder in 100 gallons gave much better control of codling moth than lead arsenate.

Xanthone (Genicide), at the rate of 2 pounds, with 4 ounces of Colloidal 77 and 1 quart stove oil (Plot 8) gave control slightly better than lead arsenate and also gave commercial control of spider mites.

A combination of xanthone and DDT (Genicide A), 2 pounds with 4 ounces of Colloidal 77 and 1 quart stove oil gave excellent codling moth control and commercial control of spider mites, but it greatly accentuated the russetting on Bosc pears, and caused a tan blotching on Anjou and Comice pears (station).

The most outstanding control was obtained from the use of DDT in various schedules. Very good control was obtained from the use of as few as three cover sprays of 0.5 pound of actual DDT per 100 gallons, applied at the time of the 1st, 3rd, and 5th cover sprays of the standard lead arsenate schedule (Plots 4,5), in spite of the fact that these trees were intermingled with trees sprayed with less effective materials. In 1946 spider mite infestation was not more severe on trees sprayed with DDT than on those sprayed with lead arsenate.

Spray Deposits and Residue - Residue and deposit analyses were made through the courtesy of R. H. Robinson, Chemist, Oregon Experiment Station, Corvallis. Even on the unwashed fruit the DDT residue at harvest time was below the proposed tolerance in all cases.

DDT Deposits on Pears Before and After Fifth Cover Spray and at Harvest

Plot and No. of Covers	Variety	Sample Collected	Date	DDT Deposit mic/sq.cm.	DDT Deposit p.p.m.
Plot 5					
DDT in 1,3,5	Bartlett	Before 5th	Aug. 7	1.6	1.6
		After 5th	" 9	5.3	5.3
		At harvest	" 20	4.1	3.8
Plot 10					
DDT in 1,2,4	Bartlett	At time of 5th	Aug. 7	2.7	2.8
		At harvest	" 20	2.3	2.1
Plot 11	Bartlett	Before 5th	Aug. 7	3.6	3.5
DDT in 5 covers		After 5th	" 9	6.3	6.3
(¾ pound 1,2,3)		At harvest	" 20	6.0	4.6
Plot 12	Bartlett	Before 5th	Aug. 7	2.3	2.3
DDT in 1,2,3,5		After 5th	" 9	6.3	6.4
		At harvest	" 20	4.4	4.0
Station	Anjou	At time of 5th	Aug. 9	6.8	6.9
DDT in 1,2,3,4		At harvest	Sept. 5	3.1	2.9
Station (Upland)	Anjou				
DDT in 5th, 4 l.ars.		After 5th	Aug. 14	3.3	2.9
Station	Bartlett	At time of 5th	Aug. 9	5.1	5.1
DDT in 1,2,3,4		At harvest	" 20	4.4	4.0
Station	Bartlett				
DDT in 4th, 3 l.ars.		At harvest	Aug. 20	2.6	2.4
Station	Bosc	Before 5th	Aug. 9	1.8	1.9
DDT in 1,2,3,5		After 5th	" 11	7.0	7.1
		At harvest	Sept.20	3.5	3.3
Station	Comice	At time of 5th	Aug. 9	6.4	6.5
DDT in 1,2,3,4		At harvest	Sept.30	3.1	3.2

Washing Tests for Removal of DDT

Plot No.	Washing Solution	DDT Residue Unwashed p.p.m.	DDT Residue Washed p.p.m.
Plot 10	Vatsol to foam in HCl at 70 deg. C.	2.1	1.9
Plot 11	" " " " " " " " "	6.0	4.6
Plot 12	" " " " " " " " "	4.0	3.5

Washing pears in an acid bath removed only from 9.5% to 23.3% of the residue from the fruit.

OREGON (Continued)

Leroy Childs and R. H. Robinson, Hood River Branch Experiment Station, Hood River, and Oregon Agricultural Experiment Station, Corvallis.

Introduction

This report is confined to a portion of the results in codling moth control obtained at the Hood River Station during the past year. Orchard set-up at the Station is similar to that described in former reports. For the most part, single plots were used in 1946 consisting of 1 1/2 to 2 acres each involving 4 rows of trees, 20 trees long. The arrangement started with Experiment 1 on the West, continuing in sequence (4 trees wide) to Experiment 8 on the East. For tabulating of control the rows were divided in thirds (long way) and three trees sampled as formerly in each area of the test. An extensive uniform worm condition prevailed in 1945 in the block of trees sprayed. The carry-over into 1946 was likewise extensive as indicated by moth trap catches.

Basis for 1946 Experimental Program

Based upon two previous years experiences it was the writer's belief that DDT employed in 2 or 3 covers would adequately handle the codling moth problem in the Hood River Area. The principal ideas involving the 1946 investigations were as follows:

1. DDT used in randomized single tree or small plots surrounded by conventionally sprayed trees, would not express the complete control value of DDT such as would follow grower usage.

2. It was believed that a few applications of relative high dosage were equally or more effective than several low dosage applications.

3. Control studies involving extensive acreage which would permit studies concerning effects of DDT on the adult or moth population and the effect of mass moth population reduction on worm control and its relationship to a spray schedule.

4. Continuing investigation of DDT started in a 12-acre orchard where moth population has been recorded for the past 15 years. This observation will be continued indefinitely or until such time as DDT usage might prove undesirable. Purpose: To determine cumulative effects of extensive moth population reduction and worm control as related to future needed spray programs.

5. Effects of delaying cover sprays until after some worms had entered the fruit.

6. Continuation of studies relative to mite and woolly aphis control both of which constitutes the key to practical DDT usage.

Discussion

The tests as outlined in Table 1 were again, as in 1945, definitely exploratory. The first cover was applied May 27-29. Some stings were present and the moth population high. With the exception of 4 rows near the east side, all of the orchard--about 12 acres was sprayed with DDT, a large proportion with one pound actual DDT per 100 gallons of spray. Following the spraying the orchard was watched for further needs. The moth population was knocked down and no new stings of importance appeared throughout the area until about July 15, following which time, although the moth population was low, there occurred a gradual slight but noticeable increase. We were not seriously concerned about these entrants due to results we were obtaining (in other tests) relative to killing effects of DDT applied after the worms had entered the fruit. The second application was delayed until July 23-25. The idea in mind being to delay this spray as long as possible so that it might exert maximum influence on second brood moths. Results obtained in Experiments 1 to 5, Tables 1 and 2, where the program was not meddled with, indicates that moth population reduction doubtless assisted in the excellent worm control that followed. Results obtained in 5-a and 6-a where the top 1/2 of the trees was sprayed in the second application in the former and no spray in the latter further indicates that moth reduction contributed to the control of worms. Data gathered in Experiment 8 appear to be out of line. The area involved consisted of 4 rows of trees on the east side of the orchard adjacent to waste land. Prevailing wind direction is from the west. Many observations made in the past indicate more extensive worminess on trees so located than prevails in other parts of the orchard.

DDT plots received but 2 covers (one May 27-29 and one July 23-25) except Experiment No. 4 which received 3 covers (May 23, June 22, and July 22). The DDT formulation used was Deenate 25-W unless otherwise indicated. All plots except 1-a received a calyx application of lead arsenate 3-100 plus Fluxit spreader. DN-111 and Nacconal, 1 ounce-100, were used on all plots unless otherwise indicated.

The mite problem proved to be an enigma throughout the season. There occurred no early extensive increase. Some mites were present at the time of the second application. Infestation from tree to tree was so variable no attempt was made to determine comparable infestations occurring in the different plots.

During late summer plot 4 developed a rather extensive uniform infestation. The damage was of commercial importance as size of fruit was somewhat smaller and leaf damage extensive. In the others, even where no mite spray was employed, Experiment 5, population was inconspicuous until near harvest time. Perhaps the general use of a

miticide in the orchard (applied before mites were found, though probably present) had something to do with the general condition. We believe keeping ahead of the mites is a good idea even to the extent of spraying for them early in the season when not a mite can be found.

Woolly aphis did not develop in the same proportions during 1946 as in the past. Black leaf 40 as used in Experiment 2 kept the insects well in check as far as the practical control of the insects are concerned but probably not to the degree needed for the prevention of perennial canker increase. It was noticed that some parasites Aphelinus mali and several species of syrphids survived the treatments as used. At times syrphid larvae were quite abundant.

Table 1. Codling Moth Studies, 1946 - Variety, Newtown

Experiment No.	Materials Used 1/ (Amounts per 100 Gallons)	Condition of Fruit % Wormy	% Stung	% Clean
1	1st Cover, DDT 1 lb.; DN-111, 1/2 lb. 2nd Cover, same.	.39	4.4	95.1
1-a	Same as Experiment 1 - no calyx.	.42	3.8	95.6
2	1st Cover, DDT 1 lb., DN-111, 1/2 lb. 2nd Cover, DDT 1/2 lb., DN-111, 1/2 lb. Black Leaf 40, 3/4 pt.	2.1	5.7	93.0
3	1st Cover, DDT 1 lb., DN-111, 1/2 lb. 2nd Cover, Genicide A, 1 1/3 lb., Genicide, 1/3 lb., DDT 1/3 lb.	1.3	4.1	94.9
4	1st Cover, DDT 1 lb., DN-111, 1/2 lb. 2nd Cover, same except DDT, 1/2 lb. 3rd Cover, DDT 1/4 lb., DN-111, 1/2 lb.	1.2	4.4	94.8
5	1st Cover, DDT 1 lb. 2nd Cover, same.	.98	4.2	95.2
5-a	1st Cover, same as 5. 2nd Cover, same, only top 1/2 of trees sprayed.	3.2	9.1	88.8
6	1st Cover, DDT 1 lb., Shell light oil, 2.5 qt., Coll. 77, 1/4 lb., 2nd Cover, DDT 1 lb., Shell light oil, 1 gal., Coll. 77, 1/4 lb.	2.8	8.3	89.2
6-a	1st Cover, same as 6; no further spray.	5.8	10.4	85.6
7	Calyx and 6 covers lead arsenate, 3 lb., oil, 2 qt. in 1, 2, 3, plus Coll. 77, 1/4 lb. in 4, 5, 6, with Fluxit, 2 oz.	7.3	29.4	66.9
8	1st Cover, DDT 2/ 1 lb., Shell light oil, 2 qt., 2nd Cover, DDT 2/ 1/2 lb., DN-111, 1/2 lb. Z-1, 1/4 lb.	4.6	11.1	86.1
9 3/	Calyx and 6 Covers Lead arsenate, 3 lb., plus Fluxit, 2 oz.	4.5	51.3	46.9

1/ DDT expressed as actual DDT.
2/ From Deenate 50%.
3/ Experiment 9 program and injury that developed in that part of the orchard used in the moth trap study. This block of orchard cannot be directly compared with Experiments 1 to 8, inclusive.

Table 2. Worm Condition Prevailing in Plots in the Orchard in 1945 Where Some of the Tests were Applied in 1946.

1946 Test Nos.	Percent Worm Injury in Harvested Fruit					
	1945			1946		
	Worms	Stings	Clean	Worms	Stings	Clean
Experiment						
1	18.1	16.4	72.5	.39	4.4	95.1
2	15.0	17.3	73.4	2.1	5.7	93.0
3	23.8	17.8	64.7	1.3	4.1	94.9
4	11.8	27.0	65.8	1.2	4.4	94.8

This table indicates the character of worm damage occurring in plot tests in 1945 and the extent of moth carry-over to which the above 4 tests were exposed--in part--in 1946. See Table 1 for 1946 program. Two cover sprays only of DDT were applied in Experiments 1, 2, and 3 of one pound each. Experiment 2 was sprayed with 1/2 pound in the second cover. Experiment 4 received three applications of 1 pound, 1/2 pound and 1/4 pound. The area sprayed in each test was 4 rows wide and 20 rows long; approximately 2 acres each. The tests followed in sequence beginning with row 1 on the west side of the orchard continuing to the east. This plan was followed in tests 1 to 8 inclusive, Table 1.

Ten moth traps were operated in the area involving Experiments 1 to 3 inclusive. Two covers of 1 pound DDT-100 were used with the exception of Experiment 2 where 1/2 pound was employed in the second cover. Experiment 4 received 3 covers at the rate of 1 pound, 1/2 pound and 1/4 pound DDT. In this area 10 traps caught 183 moths after the first DDT cover during the season. In a comparable block of trees sprayed with six covers of lead arsenate 2,831 moths were caught. At the time of the first DDT application, 36.5 percent of total moth emergence had occurred. The greatest number of second brood moths taken in any 2-day period in the arsenate sprayed orchard (traps examined at 2-day intervals) was 360, DDT 22. There occurred 46 days during the season when no moths were caught where DDT was used and 14 days in the lead arsenate area. In the DDT sprayed area where 1 pound of DDT was used in two applications (Average Experiments 1 and 5, Table 1) fruit condition at harvest time was as follows: wormy, 1.52 percent; stung, 4.4 percent; fruit free from worm damage, 95.2 percent. The following condition was found in the lead arsenate sprayed area: (bait trap area Experiment 9, Table 1) wormy, 4.5 percent; stung, 51.3 percent; apples free from worm damage, 46.9 percent. It is believed the high degree of control obtained in the DDT area was due to the combined effects of moth and worm control.

Table 3. Effect of DDT on First Brood Side Worms Established in Apples before Spraying, 1946. (No calyx spray applied.)

Expt. No.	Material 1/ and Spray Date	Days 2/	Worm Condition (Percent): Dead In Apple, June 12	Dead In Apple, July 4	Prematurely Missing, June 12	Prematurely Missing, July 4	Alive, June 12	Alive, July 4 3/
W-1	DDT 25% 1 lb. actual-100 Sprayed 6/6	12	47.0	53.0	42.0	38.0	11.0	9.0
W-2	DDT 50% 1 lb. actual-100 Sprayed 6/6	12	40.0	49.0	51.0	46.0	9.0	5.0
W-4	DDT 25% 1 lb. actual-100 Sprayed 6/12	18	57.0	49.0	29.0	38.0	14.0	13.0
W-3	DDT 25% 6/10 lb. actual-100 Sprayed 6/3 No spreader	9	45.0	43.0	46.0	50	9.0	7.0
W-Ck.	No Spray	-	7.5	6.0	21.0	11.5	76.4	81.6

1/ Nacconal 1 oz.-100 used as spreader in all sprays except W-3.
2/ Days following first worm entry before spray was applied.
3/ Includes worms that matured and left apples. No maturity had occurred in earlier observation.

The above table summarizes some of the observations made with reference to effect of DDT applied after worms had entered the fruit. The findings are quite similar to preliminary results noted in 1945. Killing of calyx worms was not quite as fast or as effective as for side worms. The results were as follows. Experiment W-1, dead, 42.3 percent. Prematurely missing, 40 percent; alive, 14 percent. Experiment W-2, 38.7 percent, 30.7 percent, and 20.2 percent respectively. W-4, 44.5 percent, 23.7 percent and 25.0 percent; unsprayed fruit, 1.0 percent dead, 13.0 percent prematurely missing and 79.0 percent alive. Approximately 50 percent of the worms recorded as living in the last observation were sub-normal. In the second cover in these tests 14 to 19 percent side worms allowed to enter fruit for two weeks before spraying survived; no calyx observations were made.

Table 4. DDT on Apples and Leaves from Hood River Experimental Plots, 1946 1/

Experiment No.	Deposit	Micrograms per sq. cm. 1st Cover Leaves	1st Cover Apples	2nd Cover Leaves	2nd Cover Apples	Harvest Leaves	Harvest Apples	Residue Apples ppm
	Before	--	--	2.3	2.5			
1	After	17.0	14.2	19.8	10.3	5.9	5.1	5.3
	Before	--	--	1.8	2.0	-	-	-
2	After	15.2	13.1	9.4	5.7	5.4	5.5	6.1
	Before	--	--	1.7	1.9	3.7	4.0	4.4
3	After	--	--	9.2	6.6			
	Before	--	--	1.6	3.0			
4	After	9.0	7.0	6.6	5.5	2.2	2.7	2.9
	Before	--	--	1.8	2.0			
5	After	23.0	13.1	18.9	11.5	4.3	6.1	6.1
	Before	--	--	4.8	5.5			
6	After	20.2	16.1	16.7	11.0	9.3	4.7	5.1
	Before	--	--	1.9	1.7			
8	After	21.0	15.8	11.3	6.0	7.4	5.5	6.1

1/ For spray treatments, see Table 1.

Discussion - Deposit and Removal

Commenting first on the analyses for deposits on both leaves and apples of samples collected after the first cover and before and after the second cover and at harvest time, the data for DDT on the leaves indicate losses by decomposition on exposure to the air and sun or possibly by rain wash although I doubt that the rain contributed very much to the losses. The leaves chosen for analyses were approximately the same size and hence smaller amounts of DDT found two months later would not be due to increase in size of leaves. The apples, on the other hand, increased materially in size and therefore, the square centimeter area would likewise increase. The losses on the apples between the second cover and harvest were not as great as I would have anticipated. In fact, I am of the opinion that most of the DDT dissolved in the waxy surface of the apple and remained there with little chemical change or loss. I made a few hurried calculations and on the basis of the weight of the apple at harvest and after the second cover spray, the amount of DDT found was nearly identical. With the spray program used, however, none of the plots showed a residue above 7 p.p.m. Plot No. 6 however, showed heavier deposits due to oil. You will also note that in plot 5 where no Nacconol was used, a higher deposit was found than in the other plots similarly sprayed. It is quite apparent that the spotted condition of the fruit accounted for the higher results.

In the washing tests I chose apples from the various plots picking only those that showed apparent residue and which as a consequence showed a little more residue deposit upon analysis than the average run apples picked from the same plot. The Newtown apples used where the notation "waxy" is indicated were picked from the broken limb of the tree in plot 1. These apples were abnormal in that they felt waxy. The results of the washing tests indicated that when Vatsol is used in warm water at about 95°F. one can reply upon one-third to one-half of the residue being removed.

VIRGINIA

C. H. Hill, Virginia Agricultural Experiment Station, Blacksburg.

Results of two orchard tests on codling moth control in 1946 are summarized in Tables 1 and 2, showing average number of "stings" and "worms" per hundred apples counted. In counting the apples all drops were picked up in the early counts and all or up to a hundred in the later counts (just prior to harvest). On each count one hundred apples were examined on two sides of the tree using a ladder. All sprays in both tests were applied in addition to the orchard's regular spray program which included six lead arsenate covers. The trees were randomized and replicated four times.

Table 1. C. J. Kinzie Orchard, Daleville, Virginia

Sprays Applied on Top of Regular Orchard Program	No. of Appli-cations	Average per 100 Apples Examined	
		Stings	Worms
DDT, 3/4 lb.	2	0.5	0.4
DDT, 3/4 lb.	4	1.0	0.4
DDT, 1 1/2 lb.	2	0.8	0.8
DDT, 1 1/2 lb.	4	0.3	0.4
Black Leaf 40, 1/2 pt.; DDT, 1/2 lb.	4	0.9	0.5
Loro, 1/2 pt.; kerosene, 1 gallon	4	1.0	0.3
Black Leaf 155, (7% nicotine & 17% DDT) 3 lb.	2	1.4	1.8
Check (regular orchard treatment)		3.1	2.4

The amounts of DDT shown in Table 1 refer to the actual amounts of DDT contained in the formulations. Geigy's Gesarol AKZ-40 was used. The sprays were applied May 9, May 17, June 21 and July 1. Those receiving only two applications were sprayed May 9 and June 21. The fruit was examined and counts taken July 18 and 19 and August 26.

Table 2. Nininger Orchard, Daleville, Virginia

Sprays Applied on Top of Regular Orchard Program	No. of Applications	Average per 100 Apples Examined	
		Stings	Worms
DDT, 3/4 lb.	2	0.8	4.0
DDT, 3/4 lb.	4	0.1	1.1
DDT, 1 1/2 lb.	2	0.4	1.5
DDT, 1 1/2 lb.	4	0.2	0.5
Black Leaf 40, 1/4 pt.; DDT, 1/2 lb.	4	0.5	0.7
Loro, 1/2 pt.; kerosene, 1 gallon	4	0.4	2.1
Black Leaf 155, (7% nicotine & 17% DDT) 3 lb.	2	0.4	1.0
Check (regular orchard treatment)		0.5	4.0

The amounts of DDT shown in Table 2 refer to the actual amounts of DDT in the formulations. DuPont's Deenate 50W was used. The sprays were applied May 10, May 16, June 19 and July 8. Those receiving only two applications were sprayed May 10 and June 19. The fruit was examined and counts taken July 19 and September 14-16.

Codling moth infestation in this area was very low this year apparently due largely to lack of fruit the previous year. Most of the injury to the fruit was due to a late second brood.

VIRGINIA (Continued)

A. M. Woodside, Field Laboratory, Virginia Agricultural Experiment Station, Staunton.

On account of the very light crop of apples in 1945 the carry-over of codling moths in central Virginia in the spring of 1946 was generally the lightest in many years. In orchards which had borne a considerable part of a normal crop in 1945 this was not true, as the bait trap catch of spring-brood moths in two such orchards was the highest ever recorded here. The catch in May in these two orchards was 281 and 221 moths per trap.

The weather during May was generally cool with frequent rains, and the emerging moths either laid few eggs, or the larvae that hatched from many of them perished. Very little fruit infestation was observed, even in orchards with a heavy emergence of moths, until after the middle of June. Appearance of first-brood moths was delayed until much later than the time that has been regarded as normal. Fruit infestation at harvest was the lowest in at least 15 years. Growers who used DDT were pleased with the control obtained, but it is unsafe to draw conclusions on the past season's experience.

Mites were generally injurious in orchards where two or more DDT sprays were applied, and they generally caused no damage where DDT was not used. An exception was an orchard in which three DDT sprays had been applied in 1945 and none used in 1946. Here the infestation of mites became severe.

VIRGINIA (Continued)

W. S. Hough, Winchester Research Laboratory, Virginia Agricultural Experiment Station, Winchester.

In the season of 1946 codling moth injury was below normal. Summary of more important tests with new insecticides is given below:

Amount in 100 Gallons (Calyx Spray - Lead 3 lb. All Plots; 5 Cover Sprays of Indicated Insecticide)	Live Entries %	Total Injuries %
Oak Grove Orchard		
Lead 3 lb., lime 2 lb.	10.1	10.7
Ryanex 6 lb.	11.8	15.9
Velsicol-1068 20% Conc. 2 gal.	10.9	12.4
Methoxy DDT 50% 2 lb.	5.2	5.2
Genicide A 2 lb. 1/	1.6	2.3
50% DDT 1 1/2 lb. (Av. of 7 plots)	0.4	0.5
Check, not sprayed	68.5	70.6
Cather Orchard		
50% DDT 1 lb., finely micronized	4.9	4.9
50% DDT 1 lb., coarsely micronized	18.3	19.1
Millers 30% DDT liquid 1/3 quart	10.2	10.3
Millers 30% DDT liquid 2/3 quart	6.2	6.6
Syndeet 1 pint 2/	20.5	20.8
50% DDT 1 1/2 lb. (Av. of 27 plots)	1.8	2.9
Lead 3 lb., lime 2 lb.	17.4	19.0
Check, not sprayed	71.5	71.9
Laboratory Tests on Toxicity		
Lead 3 lb., lime 2 lb.	22.9	43.1
Ryanex 6 lb.	6.2	12.7
Velsicol-1068 20% Concentrate 2 gal.	58.7	65.5
Gamtox 6 lb. 3/	53.5	58.1
Syndeet 1 pt. 2/	2.0	5.6

See next page for footnotes.

1/ 37.5% DDT and 45.5 xanthone
2/ 25% DDT by weight or about .28 pound in 1 pint
3/ About 30% benzene hexachloride containing 12% gamma isomer.

Only five trees were sprayed with Velsicol-1068 in the orchard and these were among trees sprayed with DDT which almost eliminated the moth population. Velsicol-1068 showed very low toxicity to codling moth larvae in the laboratory tests. Laboratory tests show comparative toxicity of the insecticides within a few hours to not more than three days after spraying.

DDT Residues.--All commercial orchards receiving the fifth cover in late July yielded fruit within the .050 gr./lb. limit when harvested in September. Experimental lots sprayed (sixth cover) on August 8 and 9 yielded fruit carrying average residues of .057 to .088 gr./lb. when picked on September 9, and .055 to .059 gr./lb. when picked October 4.

CANADA (British Columbia)

J. Marshall and C. V. G. Morgan, Dominion Entomological Laboratory, Summerland.

1. Tree Trunk Sprays

During 1946 it was determined that when 7 pounds 40 percent dinitro-o-cresol formulation are applied with 20 gallons distillate oil per 100 gallons trunk spray mixture, it is not necessary to add a specific emulsifier since the extender in the two types of formulations that were used has dispersive properties. Presence of sodium lauryl sulfate emulsifier in trunk sprays tended to increase the run-off of oil-dinitro-o-cresol and reduce the larval mortality. Addition of 1 gallon oleic acid per 100 gallons distillate oil (38 S.S.U. Vis. 100° F.) - dinitro-o-cresol measureably increased larval mortality. Dinitro secondary butyl cyclohexylphenol, a compound more soluble in petroleum than dinitro-o-cresol, appeared somewhat more toxic to cocooned codling moth larvae.

2. Summer Sprays (Experimental)

Duplicate 3 tree plots; McIntosh 35 years old; 6 cover sprays; 1 gallon spray per box maximum crop each application; two gun stationary sprayer 400 pounds at guns (approximate); check plots adjoined all experimental plots and sprayed with natural cryolite 4 pounds--summer oil 0.5 gallon (4 sprays) 0.25 gallon (2 sprays)--monoethanolamine-tall oil soap 0.25 pound (4 sprays) 0.12 pound (2 sprays). Picked and dropped fruit checked at harvest, 500 fruits per tree. Figures represent average percent wormy fruit in whole numbers for duplicate plots with adjoining checks. Amounts of materials per 100 imperial gallons. Spray dates; May 23, May 30, June 7, June 21, July 26, and August 12.

Benzene hexachloride - water suspension 0.25 pound gamma isomer first five sprays, DDT 50% 2 pounds last spray. 14% (Check 2%) 12% (Check 6%).

Phenothiazine (Micronized) - 0.75 pound - stove oil 1 quart - soya flour 4 ounces first three sprays. Nicotine sulfate 40% 10 ounces - Mississippi bentonite 4 pounds - summer oil 0.5 gallon. Monoethanolamine - tall oil soap 0.25 pound last three sprays. 1% (Check 2%) 4% (Check 6%).

Cryolite, Canadian micro-ground - 4 lb. summer oil 0.5 gal. (4 sprays) 0.25 gal. (2 sprays) - Monoethanolamine-tall oil soap 0.25 lb. (4 sprays) 0.12 lb. (2 sprays). 3% (Check 3%) 5% (Check 6%).

Tobacco Residue-DDT (Tobacine) - 1 qt. 1% (Check 1%) 2% (Check 7%).

DDT 50% Wettable 1 lb. (1-6 covers) - pyrophyllite 2 lb. (3-6 covers only) 3% (Check 1%) 2% (Check 7%).

DDT 50% Wettable 1 lb. - 1% (Check 3%) 3% (Check 12%).

DDT 50% Wettable 1 lb. - dicyclohexylamine dinitrocyclohexylphenolate 20% - 0.5 lb. 2% (Check 3%) 2% (Check 12%).

DDT 50% Wettable 1 lb. - Ammonium dinitrocyclohexylphenolate 2 oz. 1% (Check 6%) 1% (Check 4%).

DDT 40% 0.5 lb. - xanthone 60% 0.75 lb. (i.e. 1.25 lb. special formulation) 3% (Check 6%) 5% (Check 4%).

DDT 20% 0.5 lb. - Elemental sulfur 40% 1 lb. - Inert 40% 1 lb. (i.e., 2.5 lb. special formulation) 6% (Check 4%).

Turbine Air Blast Sprayed - 3,4,5,6 covers only on a single 8 tree plot) - DDT-talc 10% dust plus stove oil 10% emulsion (monethanolamine-tall oil 1% of stove oil). About 8 oz. DDT and 1 pint stove oil applied per tree per application. 1% (Check 3%).

Mite Infestation (Experimental Plots)

Cryolite-oil (check plots) - relatively few European red mite but Pacific mite built up noticeably late in the season. Condition of trees good. Phenothiazine-fixed nicotine plot - somewhat more European red mite than check plots. Similar Pacific mite. Foliage dark green, healthy. Mildew not controlled. Benzene hexachloride plot - European red mite fairly numerous although not as numerous as DDT plots. Pacific mite fairly numerous. Condition of foliage fairly good. No obvious injury from five applications 0.25 lb. gamma isomer. Blister mite not controlled.

DDT-tobacco residue (Tobacine) plot - very few mites of any kind. Condition of foliage good.

DDT-pyrophyllite and DDT alone - both species mites very numerous. Foliage poor because of mite injury.

DDT-DN-111 plot - few red mites, few Pacific mites. Condition of foliage good.

DDT-ammonium salt of dinitrocyclohexylphenol plot - less mites than on any other trees in orchard. Foliage excellent.

DDT-xanthone plot - relatively few red mites and Pacific mites. Mildew not controlled. Condition of foliage good.

DDT-sulfur plot - European red mite numerous. Pacific mite very few. Foliage bleached because of European red mite activity. Many winter eggs of this species.

Woolly Aphid Infestation

Apparently slight increase where DDT applied.

Spray Injury

June 20 - after 3 cover sprays slight nitro injury on McIntosh where ammonium dinitrocyclohexylphenolate oversprayed with summer oil 0.5% from adjoining checks. No injury from phenothiazine, benzene hexachloride, xanthone, or DDT. August 20 - no further injury.

DDT Residue (Experimental Plots)

Materials per 100 Gallons	Type of Deposits	Mg/Kg DDT Residue at Harvest	
DDT 7.5 oz. (as Tobacine)	Brown blotch - tenacious	4.4	8.1
Duplicate		5.8	6.0
DDT 0.5 lb. (as 50% Wettable) Pyrophyllite 2 lb.	Spot - blotch	2.7	2.8
DDT 0.5 lb. (as 50% Wettable)	Spot - blotch	2.8	3.1
DDT 0.5 lb. (as 50% Wettable) Dicyclohexylamine dinitrocyclohexylphenolate 20% 0.5 lb.	Spot	2.4	3.3
DDT 0.5 lb. - ammonium dinitrocyclohexlphenolate 2 oz.	Blotch - film	3.0	3.3
DDT 0.5 lb. - xanthone 0.75 lb.	Blotch	1.8	2.9
DDT 0.5 lb. - sulfur 1.5 lb.	Spot	2.7	3.2
DDT - talc - stove oil applied by turbine sprayer-duster	Film	4.1	5.1

3. Summer Sprays (Grower Trials)

Seven growers each supplied with sufficient DDT 50 percent wettable (either Penn. Salt or C.I.L. (DuPont) for five to six applications of 320 to 500 gallons. At harvest, infestations compared to neighboring trees that received regular spray schedule (either cryolite-protein spreader or phenothizaine first brood, fixed nicotine-oil second brood).

Codling Moth Infestation at Harvest

Orchard No.	Grower Schedule (Percent)	DDT Plot (Percent)
1	29	13
2	3	5
3	12	3
4	1	1
5	20	1
6	15	5
7 Jonathan	16	2
7 Newtown	11	5
Average	13	4

Mite and Woolly Aphid Infestations (Grower Plots)

Orchard No.	European Red Mite	Pacific Mite	Woolly Aphids
1	More numerous	More numerous	More numerous
2	More numerous	More numerous	More numerous
3	Much more numerous	Little change	More numerous
4	No change	No change	Some increase
5	Slight increase	Not troublesome this orchard	Not troublesome this orchard
6	Very pronounced increase	Not troublesome this orchard	Not troublesome this orchard
7	Considerable increase	Considerable increase	No change

DDT Residues at Harvest (Grower Plots)

Six sprays DDT 0.5 lb.:100 imperial gallons, last application first week in August resulted in maximum DDT residue of 3.1 mg/kg.

CANADA (Continued)

W. G. Garlick and W. L. Putman, Dominion Entomological Laboratory, Vineland Station, Ontario.

1. Seasonal Conditions and Status of Codling Moth Infestations During 1946.

In the areas where codling moth is usually serious the first moths emerged and the first larval entries occurred on about the same dates as in average years. Subsequent cool weather, and in particular cool evenings, delayed activity and emergence so that the peak of the latter was approximately a week later than it has been for several years. These late moths augmented the first generation moths and, aided by favourable weather, gave rise to much serious injury in a few orchards where the cover sprays were completed before the middle of July or had not been thoroughly applied. In general codling moth was readily controlled by proper spraying.

111. Results of Control Experiments

Orchard A

Plots - Large McIntosh, 6-tree plots, duplicated in another section of the orchard. Sprayed from ground with single guns, 20 gallons per tree. Whole of remaining block sprayed with DDT. Materials per 100 Imp. gallons given below. Actual DDT is given, the material used being 50 percent micronized in pyrophyllite.

1 - DDT 1 lb. in covers 1,3,5. Lead arsenate + 1% oil in 2,4,6.
4 - DDT none, lead arsenate in covers 1-4, 1% oil in 2-4. Cryolite 5 and 6.
5 - DDT 1 lb. in all six covers, no miticide.
8 - DDT 1 lb. in covers 1,2,3,5. 1/2 lb. + 1% oil in 4 and 6.
2,3,6,7 - All had DDT 1 lb. in six covers plus different miticides in covers 4-6.

Results - All plots except 4, yielded 98.5% or higher fruit free from codling moth injury. Plot 4 ran 89.4% clean fruit. The use of DDT on the surrounding block may have contributed to the good results in Plot 4 where no DDT used.

Residue - At harvest on plots 1 and 5, .019 and .016 gr./lb. respectively.

European red mite - Built up slowly and very late in season; was not overly serious even in plot 5. Live mites per leaf (count of 50 leaves per treatment, September 9) 61 for plot 5; 10 where DN-111 used; 5 and 4 for ammonium and sodium salts of DNOCHP respectively; 3 for Xanthone; 8 in plot 4 and 1, and 1 in plots 1 and 8.

Orchard B

Plots - Small plots in duplicate, mixed varieties. Four covers used. Plot 1 Gamtox 5 pounds (4.6% gamma benzene hexachloride) in all covers. Plot 2 DDT 1 pound (Geigy AK-40) in covers 1, 2. DDT 8 ounces + 1% oil in 3 and 4. Plot 3 lead and oil schedule (lead arsenate in 1-4 plus oil 1% in 2-4).

Results - The benzene hexachloride gave so little control (only 24% clean fruit) that the adjacent plots were undoubtedly influenced detrimentally. The DDT plot gave 72% clean fruit and the lead-oil 78%.

European red mite - caused slight discolouration of foliage in benzene hexachloride plot (others received oil) but predators quickly built up at this stage and the mites were practically cleaned up.

Aphids - *Aphis pomi* on inner suckers was markedly reduced by benzene hexachloride.

Orchard C

A small orchard of McIntosh and Spy received three covers of lead with 1% oil in the last two. DDT 4 oz. per 100 Imp. gal. was added to the spray in half the orchard. Three covers was insufficient but the small amount of DDT did give slightly more codling moth-free fruit (McIntosh 4%, Spy 13%). Because of the oil, European red mite did not become serious but it did build up much more rapidly where the small amount of DDT was added to the spray.

Orchard D

Similar to orchard C above except that DDT 6 oz. was added to the spray in half the orchard. Counts on Delicious showed an improvement of 22% clean fruit where DDT was used. On this variety red mite built up to a fairly high population (despite the oil used in second and third covers) and, where DDT was used, caused marked discolouration of the foliage. Also calyx depressions on the fruit were often red with mite eggs.

Laboratory Tests of Insecticides Against Newly Hatched Codling Moth Larvae.

Methods - Procedure was essentially the same as that ~~described in the~~ 1944 Report, Part 1, p. 109. Wealthy apples were used in all tests; these were in rather poor condition after storage and may have been responsible for some of the variations among replicates. A check lot of ten or more fruits, run along with each day's tests, was used as a basis for calculating the efficiency of the sprays according to Abbott's formula.

A. Tests with Benzene Hexachloride

In last year's report, Part 1, pp. 124 and 125, gamma benzene hexachloride was said to be more toxic than DDT to newly hatched codling moth larvae, on the basis of a few preliminary tests carried on in 1945. In the spring of 1946 work was continued on a larger scale to compare the toxicity of different formulations of benzene hexachloride. It was soon found, however, that this could not be done because of the very great variation of efficiency among

replicates of the different formulations. In all these tests the fan providing air circulation in the incubator containing the fruit was run at a speed just sufficient to prevent stratification. Following the lead given by some experiments with other insects, the speed of the fan was increased to give an air current perceptible in the heating compartment but which could scarcely be detected in the body of the incubator. Following this change, the variation among replications was greatly reduced but the control given by benzene hexachloride dropped considerably below that afforded by DDT.

An example of the results obtained at the higher fan speed is given in Table 1; in these tests the fruits sprayed with each material were divided into 3 lots, one being tested immediately and the other two being held for 3 and 6 days respectively at a temperature of about 50°F. in a room with fan-produced air circulation. Other formulations of benzene hexachloride tested on a smaller scale gave as poor or poorer results.

The high efficiency shown by benzene hexachloride in the preliminary tests reported in the authors' earlier paper was undoubtedly due to fumigant action, which was greatly reduced by a slight increase in air movement. The volatility of this compound which enabled it to act as a fumigant also led to gradual loss of toxicity of the residue against codling moth.

Table 1. Relative Toxicity of DDT and Gamma Benzene Hexachloride Average of 4 Replicates of 9 Fruits Each.

Materials: lb. per 100 gal. Formulation	Active ingredient	Age of spray deposit. Days	Total larvae	Percentage efficiency
40% DDT spray powder	DDT			
0.75	0.3	1	344	81.4
0.75	0.3	3	311	76.0
0.75	0.3	6	335	78.4
P530	Gamma benzene hexachloride			
5.0	0.3	1	338	50.0
5.0	0.3	3	314	42.3
5.0	0.3	6	330	27.8

B. Tests with Other Toxicants

Two chlorinated hydrocarbons now being promoted, namely Hercules Toxicant 3956 (a chlorinated terpene) and Velsicol 1068 (a mixture of isomers with the empirical formula $C_{10} H_6Cl_8$) were tested in comparison with DDT. Results in Table 2 show that in these tests both materials apparently had negative efficiencies, i.e. more larvae entered fruits sprayed with 3956 and 1068 than

the unsprayed checks, although this result was probably fortuitous.

Table 2. Relative Toxicity of Hercules Toxicant 3956, Velsicol 1068 and DDT. Averages of 4 Replicates of 9 Fruits Each

Toxicant per 100 gal.	Formulation	Total larvae	Percentage efficiency
DDT 0.3 lb.	Gesarol AK-40	351	78.6%
Hercules Toxicant 3956 0.3 lb.	25% wettable spray powder	322	-13.6%
Velsicol 1068 0.3 lb.	10% in white oil emulsified with Cal. caseinate	328	- 7.5%

Effect of DDT on Adult Codling Moths

Orchard trees were sprayed on July 12 with 1 lb. actual DDT per 100 Imp. gal. (50% DDT micronized in pyrophyllite). Twigs were collected 1, 3, 8 and 14 days later and placed in bottles of wet sand in battery jars with newly emerged adult codling moths (usually 6 males and 6 females per jar) together with a bottle of water containing a wick to supply moisture for the moths. Comparable series were run with twigs from unsprayed trees. In some of the later tests scarcity of males probably resulted in a few unfertilized females and consequently low oviposition, but this applied equally to both treatments and checks. Results were as follows:-

Table 3. Toxicity of DDT to Adult Codling Moths

		Age of spray deposit							
		1 day		3 days		8 days		14 days	
		DDT	check	DDT	check	DDT	check	DDT	check
Av. longevity in days	males	1.9	6.4	3.3	7.0	3.0	6.6	5.0	8.7
	females	2.0	6.7	4.0	8.2	3.5	7.7	6.3	10.4
Av. no. of eggs laid per female		0	25.5	0.5	15.2	8.3	19.9	12.6	12.1
Total rainfall between spraying and testing		0		0		0.26 in.		0.40 in.	

Under orchard conditions, where the moths would spend the day resting on DDT-covered foliage and bark, the spray would probably cause death more quickly than in the battery jars where they rested most of the time on the glass. It appears that the moth population of an orchard would be practically eliminated at the time of spraying with DDT and that those emerging for at least a week later would have their reproductive capacity greatly reduced, at least under the relatively dry conditions prevailing during the test.

AUSTRALIA

A. J. Nicholson, Division of Economic Entomology, Council for Scientific and Industrial Research, Canberra City, A. C. T. (Chairman, Federal Codling Moth Committee).

1. Extract from Annual Report for 1945-46, virus section; codling moth.

The field experiments begun in the Australian Capital Territory in 1944-45 were continued in 1945-46 at Jerrambomberra in a plot of 120 trees containing the varieties Jonathan, Granny Smith, Macintosh Red, Twenty Ounce and Cooker. Six treatments were applied to five randomized plots of 4 trees each. A calyx spray and 6 cover sprays were applied from October 19, 1945 to February 22, 1946. Treatments were:

1. 0.1% DDT-solvent naphtha emulsion.
2. 0.1% 666-solvent naphtha emulsion.
3. 0.1% 666 NF488M.
4. 4 lb. lead arsenate, 1 lb. calcium caseinate + 0.025% DDT-solvent naphtha emulsion to 100 gallons water.
5. 4 lb. lead arsenate, 1 lb. calcium caseinate, 2 1/2 lb. 10% DDT pyrophyllite powder to 100 gallons water.
6. 5 lb. lead arsenate, 1 gallon white oil to 100 gallons water except 1/2 gallon only in calyx application.

Results were of the same order of effectiveness on both dropped and harvested fruits. The results on harvested fruit were as follows:

Treatment No.	No. Infested Fruit	No. Clean Fruit	Total No. Fruit	Percent Infestation
1	1,389	10,437	11,826	11.7
2	2,179	684	2,863	76.0
3	2,838	2,276	5,114	55.4
4	1,308	8,748	10,056	13.1
5	842	5,481	6,323	13.3
6	1,287	10,099	11,386	11.3

The general conclusion arrived at from this experiment is that 0.1 percent DDT-solvent naphtha emulsion, or quarter strength DDT either as an emulsion or as a suspension plus lead arsenate, are as good for the control of codling moth as lead arsenate-white oil. Neither of the mixtures containing 666 is of any value for this purpose.

No severe outbreak of Bryobia praetiosa or red spider Tetranychus urticae occurred on the experimental plot, but this may have been due to stringent winter control measures followed by a spring application of lime-sulfur.

At the end of the season, however, the numbers of mites had increased appreciably, and considerable numbers of eggs were deposited on fruiting spurs, limbs, etc. In May, ten fruit spurs for each of the treatments 0.1 percent DDT-solvent naphtha, 0.1 percent 666 EF488M and lead arsenate white oil, were collected at random, two spurs from each replication, and the number of mite eggs on each were counted. These numbers were compared with those obtained from ten spurs collected from an unsprayed adjacent orchard. The figures are as follows:

Mite Egg Counts from Experiment Blocks, Fisk's Orchard, Jerrabomberra, 24.5.46.

	No. 1 DDT Emulsion	No. 3 666 EF488M	No. 6 Lead Arsenate White Oil	Control
	447	185	58	1017
	192	101	58	852
	983	149	112	872
	1078	233	70	536
	342	154	298	530
	792	254	122	147
	1054	181	73	229
	1548	374	68	316
	1368	308	61	371
	1318	263	44	883
	9122	2202	964	5753
Av. per twig.	912	220	96	575

It will be seen that spurs treated with DDT carried double the number of eggs on the untreated spurs and that 666 had half as many again as the control. Spurs treated with lead arsenate-white oil only carried half the number of eggs on the controls. Thus, neither DDT nor 666 are good acaracides; 666 is better than DDT, and lead arsenate-white oil gives adequate control.

It is worth noting that in three other districts near Canberra, however, severe outbreaks of these pests did occur following the use of DDT. The first district affected was at Yass, where two rows of Rome Beauty apples in the centre of a large orchard were treated with 0.025 percent DDT suspension, plus lead arsenate 5 pounds to 100 gallons throughout the year. Excellent control of codling moth resulted, but by January 7, 1946, a very heavy infestation of <u>Bryobia</u> mite caused the trees to appear very sickly. With the exception of four trees, all affected trees were sprayed with 0.75 percent white oil. This effectively controlled the mite, but a number of apples suffered from oil burn. Of the four trees left untreated, two were left as controls and the other two treated with a new material "Dynone" (= Dow DN-111) a new acaracide for fruit trees containing dicyclohexlamine dinitrocyclohexylphenate for the control of red spider. One tree was treated with half strength "Dynone" or 1 pint in 24 gallons of water on January 11. On January 17, six days later, the tree was quite free of all living mites and most eggs on the tree were dead. A few living eggs remained in inaccessible places missed by the spray.

On this date, the same tree, together with the second tree to be treated, were sprayed with 0.1 percent DDT solvent naphtha with half strength "Dynone" as shown above incorporated. The temperature at the time of application was 90 in clear sunny weather. Approximately 3 gallons per tree were applied. On January 24th, seven days later, both trees were free from mites and very few viable eggs could be found. Neither tree showed any signs of injury, either on leaves or fruit, even though the application had been made in the heat of the day. The remainder of the trees treated with white oil were becoming reinfested on this date from the hatching of viable eggs. No further "Dynone" sprays were applied because of a lack of material and re-infestation of the two treated trees began about 10 days later from eggs in inaccessible places not reached by the spray. The results of this small field trial suggest that a combination spray of 0.1 percent DDT-solvent naphtha and "Dynone" may be safely applied to apples during hot weather and that the mixture will effectively control <u>Bryobia</u> outbreaks following the use of DDT for the control of codling moth.

At Goulburn, 60 acres of apples, 30 acres of which were 30-70 years old, were treated with 5 pounds of lead arsenate and 2 1/2 pounds. DDT dust per 100 gallons throughout the season. Codling moth had been especially difficult to control previously. The DDT lead spray gave excellent control of codling moth until the end of January when a critical spray was missed because of mechanical breakdown. Moth infestation at harvest, however, did not amount to more than 5 percent. By mid-January, however, a serious outbreak of <u>Bryobia</u> mite had developed, and remained heavy for the remainder of the season.

At Batlow, two Granny Smith apple trees were treated with 0.1 percent DDT-solvent naphtha emulsion throughout the season. Again, good control of codling moth was achieved, but in February a serious outbreak of red spider <u>Paratetranychus</u> <u>urticae</u> developed.

Thus, the general experience in commercial orchards in dry tableland areas has been that good control of codling moth can be achieved by the use of DDT sprays, but that serious outbreaks of mite and red spider developed in January and February. Until these pests can be controlled, either by combination sprays or split schedules, the general use of DDT cannot be safely recommended.

AUSTRALIA (Continued)

2. Summary of experiments with apples on Murrumbidgee Irrigation Area by E. J. Wason, Entomologist.

The main object was to ascertain the efficiency of D.D.T. as an emulsion, for the control of codling moth, and to observe its effects on tree and fruit growth. Observations were also made on the effect of D.D.T. on the incidence of other pests liable to attack pome fruit trees during the growing period. From the results it can be concluded that D.D.T. is only slightly more efficient than arsenate of lead on the Murrumbidgee Irrigation Area. While no spray injury from D.D.T. was observed, red spider and woolly aphid infestations greatly increased on trees treated with D.D.T., as compared with those given the standard treatment, and spraying with D.D.T. proved very much more costly.

Treatments and results following a calyx application and five cover sprays were as follows:

Treatment	Total Fruit	Percent of Fruit Infested	Percent of Fruit Stung
A. DDT solvent naphtha emulsion containing 0.1% of DDT	6,089	0.8	0.6
B. Lead arsenate, 3-100, + calcium caseinate, 1-100, in calyx and white oil, 1 gal.-100 in 1st, 2nd and 3rd covers, and 1 qt.-100 in 4th & 5th covers	5,626	2.3	2.0
C. Same as (B) except DDT as in (A) used in lieu of lead arsenate in 2nd and 4th covers.	5,016	1.7	1.1
D. Unsprayed check.	7,000	54.5	0.6

AUSTRALIA (Continued)

3. Summary of experiments using DDT, 666, and lead arsenate at Orange by G. Pasfield, Assistant Entomologist and J. Holbeche, Fruit Instructor.

DDT spray, at a concentration of 0.1 percent, was outstanding in controlling codling moth (Cydia pomonella) infestation of Jonathan and Granny Smith apples in comparison with lead arsenate and 0.1 percent "666" sprays at Huntley during the 1945-46 season. The average infestation of Jonathan and Granny Smiths, respectively, were 1.2 and 2.7 percent in the DDT plots, 11.4 and 16.3 percent in the lead arsenate plots and 49.4 and 59.6 percent in the "666" plots. The Jonathans received a calyx and 6 cover sprays, the Granny Smiths a calyx and 7 cover sprays.

Over 90 percent of infested fruits from trees sprayed with "666" had been entered through the calyx.

Analysis of the results (using inverse sine transformation) by comparing the percentage of infested fruits revealed a significantly lower infestation in the DDT plots than in the lead arsenate plots, and also a significantly lower infestation in the lead arsenate plots than in the "666" plots.

A heavy infestation of red mites (Bryobia praetiosa) developed on the DDT-sprayed trees in December and was controlled by one application of wettable sulfur early in January. No red mite infestation developed on lead arsenate and "666"-sprayed trees.

AUSTRALIA (Continued)

4. Codling Moth Control Experiment, 1945-46. Stanthorpe District - Queensland.

Purpose: To compare cover sprays containing DDT or 666 with those at present used for codling moth control.

Design and Layout: Five randomized blocks, each of five single tree plots. The first three blocks were situated in apple trees of the Jonathan variety, the fourth and fifth in Winesaps.

Treatments:

A - White oil, 1/3 gallon; nicotine sulfate, 1 pint; water, 80 gallons.

AO - Lead arsenate, 2 1/2 pounds; white oil 1 1/3 gallons; water, 80 gallons - for first three cover sprays. White oil, 1 1/3 gallons; water, 80 gallons - for subsequent cover sprays.

DN - DDT - 0.1 percent spray made up from a concentrate with 13.3 percent DDT in a solvent naphtha base.

DC - DDT - 0.1 percent spray made up from a mayonnaise concentrate with 20 percent DDT in an aromatic oil base.

G - Gammexane 0.013 percent spray made up from a mayonnaise concentrate with 15 percent 666 in an aromatic oil base for first two cover sprays. Increased to 0.026 percent for subsequent sprays.

Treatments AO and G were varied during the experiment - AO as indicated after the first three sprayings because of the heavy arsenical residue then showing on both fruit and foliage; G after the first two treatments because interim examinations showed that at the weaker strength, the spray was giving no apparent control.

Treatment Applications:

All experimental trees received a calyx spray consisting of lead arsenate, 2 1/2 pounds, water, 80 gallons, on 18th October, 1945.

Cover sprays of the various treatments were applied as follows:

2 Nov. 1945)	Variety	)
22 Nov. 1945)	Jonathan	)
13 Dec. 1945)	(Early maturing)	) Variety
2 Jan. 1946)		) Winesap
29 Jan. 1946		) (Late maturing)
20 Feb. 1946		)
12 Mar. 1946		)

Harvesting: Variety Jonathan was harvested 30 and 31 January and 1 February. Variety Winesap was harvested 26 and 27 March. Interim examinations of Winesap windfalls were made on 19 February and 12 March.

The numbers of harvested and windfall fruit from all trees were separately recorded.

Results: The trend of the data may be ascertained from the following table.

Percentage Harvested Fruit Free from Codling Moth Damage

		Jonathan	Winesap
A.	Oil-nicotine sulfate	97.4	90.6
AO	Lead arsenate-oil	97.1	92.6
DN	DDT in solvent naphtha	96.5	97.6
DC	DDT, mayonnaise	96.0	95.9
G	Gammexane	81.2	75.3
		± 1.210	± 0.658

At 1% level of significance:

Jonathans: A, AO, DN and DC better than G.

Winesaps: A, AO, DN and DC better than G.
DN and DC better than A.
DN better than AO.

At 5% level of significance:

Winesap: DC better than A.

Conclusions:

1. DDT cover sprays applied as required by the official lure timing service are probably rather more efficient than the white oil--nicotine sulfate and lead arsenate--white oil for codling moth control.

2. Gammexane sprays at the concentrations used, are of doubtful value in controlling the pest.

3. DDT sprays accentuated woolly aphid infestation and probably could not be used unless counter measures are available to keep this pest in check. The woolly aphid position remained normal on gammexane-treated trees.

4. DDT sprays and, to a lesser extent, gammexane sprays allowed red mite to get out of hand. The mite population was mixed, with Bryobia pretiosa and Tetranychus urticae Koch. both numerous.

AUSTRALIA (Continued)

5. Codling moth control experiments, Tasmania, 1945-46 by L. W. Miller, Entomologist.

During the 1945-46 season an experiment was conducted to determine the relative efficiencies of DDT and Gammexane in controlling the codling moth *Cydia pomonella* L.

Materials and Methods:

The DDT emulsion was of the mayonnaise type and contained 20 percent W/W DDT. This emulsion was used at a concentration of 1 part in 200 of water--the final spray containing 0.1 percent DDT.

Gammexane emulsion. This emulsion was also of the mayonnaise type and contained 15 percent W/W gammexane. This was used at a concentration of 1-150 = again being a 0.1 percent gammexane in the final spray.

A block of 90 Williams bon Chretien pear trees was used for the experiment. There were 5 replicates of each of the three treatments, there being 6 trees in each plot.

Sprays were applied at a pressure of approximately 300 pounds per square inch on the following dates: Calyx, 16th October, 1945; and 1st Cover, 9th November, 1945; 2nd Cover, 11th January, 1946.

Results:

Schedule	Mean Percentage Infestation
Lead arsenate (powder) 3 lb./100 gallons	7.3
0.1% DDT	1.2
0.1% Gammexane	27.8

The figures of the percentage infestation of each plot after being transferred to angles (angle = arsin $\sqrt{\text{percentage}}$) were subjected to an analysis of variance. From this analysis it was shown that the results obtained with the DDT emulsion were significantly better than those from either of the other schedules. Furthermore, the infestation resulting from the use of the gammexane was significantly greater than that for lead arsenate.

In view of the extremely poor results obtained with gammexane, an examination was made of the emulsion used in the tests. This emulsion

was found to be faulty since there was a marked tendency for the gammexane to crystallize out of the spray prior to being applied. The results, therefore, may be partly or wholly due to this faulty emulsion although results of other workers indicate that gammexane is not effective against the codling moth.

The DDT residues on picked fruit ranged from 1.3 to 6.0 p.p.m. The trees upon which the experiments were conducted were not infested with mites, consequently no evidence was obtained as to the effects of any treatment upon the mite population.

AUSTRALIA (Continued)

6. Codling moth control: DDT trials in Victoria by T. W. Hogan, Senior Entomologist and R. M. Stephens, Assistant Entomologist.

A summary of results published in The Journal of the Department of Agriculture, Victoria, Australia 44(9) September 1946 is as follows:

DDT has given excellent control of codling moth in tests conducted in three separate localities in Victoria. Spraying the trunks and butts of the trees with DDT emulsion did not give any improvement in control. Development of mites occurred late in the season on several plots, but although they were not a serious problem, the cumulative effect of several season's spraying will be of special interest. The foliage of DDT sprayed trees was lighter in colour than those sprayed with lead arsenate, and leaf fall occurred later.

The two types of emulsion tested were equally effective on all except one of the plots, but the DDT residues were higher on emulsion A (a 20 percent DDT emulsion in a petroleum solvent) and a reaction attributed to the solvent occurred on apples sprayed with emulsion B (a 15 percent DDT emulsion in a coal tar solvent naphtha). Analyses of fruit for DDT showed that some of the residues were beyond the statutory limit, but the development of schedules giving lower residues should not be difficult.

WASHINGTON

W. J. O'Neill, Tree Fruit Branch Experiment Station, Wenatchee.

Treatments for control of the codling moth were carried out on 34 to 40-year old Winesap, Jonathan and Delicious apple trees. The treatments used and dates they were applied are given in Table 1 and the plot arrangement and results are shown in Figure 1. There was no apparent spray injury; however, weak trees showed characteristic foliage burn which may have been independent of the sprays applied.

The results indicate that two first brood applications of DDT at 1 and 3/4 pounds per 100 gallons, respectively, were as effective as four applications at concentrations of 1, 3/4, 3/4, and 1/2 pound per 100 gallons, respectively. The number of second brood sprays, required for codling moth will probably not exceed one spray at 1/2 to 3/4 pounds applied in early July.

Mites will present a problem with this spray program and probably require the addition of acaricides in the second and third sprays with additional mite sprays only in late July and August.

DDT Residue at Harvest Time

Where three or four first brood sprays were applied the DDT residue at harvest time was not high enough to require washing the fruit. Where three or four first brood sprays and one second brood spray was applied on August 15th the DDT residue at harvest time was equal to or less than the present informal tolerance. Where five first brood airplane dusts were applied followed by two second brood ground sprays, 16 out of 30 programs were equal to or over the present tolerance. Of the remaining 14 programs only three had a residue low enough that they could be considered a safe figure. Where the total season spray program consisted of only three first brood sprays on Common Delicious the addition of miticides did not increase the DDT residue deposit to a point where washing would be required. The addition of petroleum oil in excess to one-third percent increased the DDT residue deposit to a point equal to or over the present tolerance. The same spray program will leave a heavier DDT deposit at harvest time on Winesap than on Jonathan, Common Delicious or Red Delicious and on yellow Newtown than on Rome Beauty.

TABLE I: TREATMENT AND TIME OF APPLICATION

Plot No.	Variety	Calyx	1st	2nd	3rd	4th	5th	6th	7th	8th
1	Winesap & Jon.	(1)	1# DDT (2)5/18	3/4# DDT 5/28	3/4# DDT 6/7	1/2# DDT 6/19	—	—	—	3/4# DDT 8/14
2	W. & Jon.	—	1# DDT 5/18	1/2# DDT 6/3	—	1/4# DDT 6/18				3/4# DDT 8/14
3	W.	—	1# DDT 5/20	1/2# DDT 6/3	1/2# DDT 6/10	1/2# DDT 6/21	—	—	—	3/4# DDT 8/15
3-A 3-A	W. & Jon.	—	1# DDT 5/20	1/2# DDT 5/30	1/2# DDT 6/10	—	—	2# Genicide (3) 1/6# Coll.77(4) 7/27		2# Genicide 1/6# Coll.77
4	W. & Jon.	—	1# DDT 5/20	3/4# DDT 5/30	1/2# DDT 6/14	—	—	—	—	3/4# DDT 8/15
5	Del.	—	1# DDT 5/18	—	3/4# DDT 6/8	—	—	1/2# DDT 7/9	—	3/4# DDT 8/15
6	Jon.,Rome,	3#,L.A.(5) 1/6# Fluxit (6)	3# L.A. 1 Pt. Oil	3#,L.A. 5 Pts.Oil	3#,L.A. 5 Pts.Oil	3# L.A. 5 Pts.Oil	3#,Cry. 2 Pts.Oil (7)	3# Cry. 2 Pts.Oil	3# Cry. 2 Pts.Oil	3# Cry. 2 Pts.Oil

(1) Calyx spray omitted on all DDT treatments
(2) All DDT given in actual conc. (Geigy AK-50 used)
(3) Genicide, trade product of Xanthone, Gen. Chem. Co.
(4) Coll. 77, a dry spreader deposit building material, Colloidal Products Co.
(5) L.A.: socalled flat type acid lead arsenate, Cal. Spray & Chem. Corp.
(6) Fluxit, dry spreader, Colloidal Products Co.
(7) Cry., Cryolite (Kryocide) Penn. Salt Mfg. Co.

Codling Moth injury was determined in the respective plat treatments by examining 300 fruits per tree taken at random in equal numbers from all boxes of harvested fruits. A diagram of the plat arrangement together with pertinent information is shown in Figure 1.

FIG. 1: PLAT ARRANGEMENT AND CODLING MOTH INJURY

Del. Plat 5 (46 Trees) 0.3% W 99% Cl (1)	Winesap Plat 4 (23 Trees) 1.5% W 97% Cl	Winesap Plat 3 (8 Trees) 1.3% W 97.3% Cl	Winesap Plat 2 (16 Trees) 2% W 95.7% Cl	Winesap Plat 1 (17 Trees) 0.8% W 97.8% Cl
		Winesap Plat 3A (9 Trees) 0.8% W 98.1% Cl		
	Jon. Plat 4 (6 Trees) 0.7% W. 98.5% Cl	Jon. Plat 3A (9 Trees) 1.2% W 98.4% Cl	Jon. Plat 2 (9 Trees) 1.1% W 98.6% Cl	Jon. Plat 1 (9 Trees) 1% W 98.3% Cl
		ROADWAY		
		Jon. Plat 6 (50 Trees) 4.2% W 93.5% Cl		
		Rome Plat 6 (90 Trees) 9.4% W 85% Cl		

W. indicates mean percent wormy fruit.

Cl. indicates mean percent fruit free of codling moth injury.

March 1, 1947

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Administration

Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1946

Part II

Work Conducted by the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture

Not for Publication

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This summary represents the contribution of the Division of Fruit Insect Investigations of the Bureau of Entomology and Plant Quarantine to the pool of information on the results of codling moth investigations carried on during 1946 which has been prepared in accordance with a request made by the Committee on the Codling Moth of the American Association of Economic Entomologists. Because of the general interest in insect problems arising as a result of the use of DDT for codling moth control, information has been included on the more important ones that have come to notice, including orchard mites, the red-banded leaf roller, and the woolly apple aphid. As in previous years, this is a preliminary report, circulated for the information of those interested. It is subject to revision as further review of the data may indicate, and has the status of unpublished data, not subject to quotation without permission.

The work of the Division of Fruit Insect Investigations is carried on cooperatively with several Bureau and Department units, as well as with a number of State agencies. The Division of Insecticide Investigations has continued to contribute to the work reported herein, and joint field laboratories are maintained at Yakima, Washington, and Vincennes, Indiana. The work in West Virginia is carried on jointly by the West Virginia Agricultural Experiment Station and the Bureau; the work in New York is carried on similarly with the New York Agricultural Experiment Stations.

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CONTENTS

YAKIMA, WASHINGTON

E. J. Newcomer, In Charge (Fruit Insect Investigations),
and W. E. Westlake (Insecticide Investigations).

Seasonal Conditions

Full bloom of apples was about a week earlier than in 1945. Abnormally cool weather from early June until the third week of July increased the interval between applications somewhat and the later sprays were not applied any earlier than in 1945.

Biological Observations

Emergence of moths started the first of May. There was a very heavy flight May 15-19, but an unusually small number was caught in baits after that date. The cool weather interfered with oviposition in June, and after the first attack of worms early in June, infestation of the fruit did not increase much until the second brood appeared late in July. The weather cooled off again late in August, and the season was one of the easiest in which to control worms that we have had for some years. Only about 20,000 moths were caught in five baits as compared with about 41,000 in 1944 and 31,000 in 1945.

Orchard Spraying Experiments

Spraying experiments were made in two orchards in 1946. Tests were made on Jonathans and Romes in one orchard and on Winesaps in the other. There was a good crop in both orchards, the Jonathans and Romes averaging 21 boxes per tree and the Winesaps 14 boxes per tree. Single-tree plats were used, replicated 8 times in each experiment. The replicates were scattered at random over the orchard. From each tree random samples of 250 apples were taken at harvest, including both picked and dropped fruit.

A calyx spray of 2 pounds of lead arsenate to 100 gallons was used in all of the experiments. Five cover sprays were applied at the usual intervals to the Jonathans and Romes between May 15 and July 26, and six cover sprays were applied in the Winesap orchard between May 20 and August 2.

The major experiments consisted of various combinations of DDT and xanthone compared with straight xanthone and with lead arsenate. These were intended to indicate how little DDT could be used for codling moth control and how much xanthone would be needed for mite control. Other tests included DDT with oil and with DN-111, benzene hexachloride and dianisyl trichlorethane.

Spray Deposits:- Deposit analyses were made for each major treatment after the first cover spray and before and after the second to fifth cover sprays on Romes; after the third and before and after the fourth and fifth cover sprays on Jonathans; and before and after the fifth and sixth cover sprays on Winesaps, with a few exceptions. Analyses of DDT were also made at harvest in most of these treatments. Samples were taken by clipping 25 apples at random from all parts of a tree and allowing them to fall into a tared container. The averages of the cover-spray analyses and the harvest analyses are shown in table 1.

Each sample was prepared for chemical analysis by adding a measured amount of solvent to the container, turning the jar end-over-end in a rotating machine for 5 minutes and pouring off a portion of the solution for analysis. Six percent sodium hydroxide was used as the solvent for lead arsenate, toluene for xanthone, and benzene for DDT.

Arsenic was determined by the method entitled "Extension of the Rapid Volumetric Micro Method for Determining Arsenic" by C. C. Cassil, J.A.O.A.C. XXIV, No. 1, p. 196 (1941), xanthone by the colorimetric method developed by Cassil and Hansen, and DDT by the method of Gunther in which is utilized the reaction whereby one mol. of HCl is split from each mol. of DDT upon treatment with dilute alkali. A photoelectric photometer was used to read color density in the colorimetric method employed for xanthone.

The average deposits of lead arsenate or of xanthone, when used at half strength with DDT were somewhat more than half the deposits from full-strength materials. The same thing was true of half-strength DDT as compared with full strength on the Romes but not on the Winesaps. At harvest the DDT was well below the present tolerance of 7 parts per million.

Control Results:* The results of field spraying experiments are given in table 2, and the average numbers of apples per box and percentage of dropped fruit are given in table 3. The comparative degree of color of the apples is given in table 4. An evaluation of the mite injury to the trees was made, but since this injury is reflected in the size and color of the fruit, it is not shown here. A record was also made of the number of sunburned Jonathans and Romes. Less than 1% of the apples sprayed with lead arsenate were sunburned. The other treatments resulted in 2 to 3% of sunburned Jonathans and 1/2 to 1% of sunburned Romes. Sunburning is therefore not important.

In evaluating the treatments, all of the factors just mentioned have to be considered, since any gain in clean fruit may be more than offset by a loss in color and size.

Taking the combination DDT-xanthone treatments as a group, the quantity of DDT was decreased and the quantity of xanthone was increased in plats 4 to 6, and the percentages of wormy and injured fruit increased, although the differences were not significant. The use of the smallest quantity of DDT (2 oz.) in this combination, however, resulted in only about half as much wormy and stung fruit on the average as from the standard lead arsenate or straight xanthone treatments; and in most cases the differences were significant. In plat 7, 6 oz. of DDT with 1 lb. of xanthone, results were very similar to those in plat 4, 6 oz. of DDT and 1/2 lb. of xanthone.

There are some discrepancies in the size of the fruit of the different varieties, perhaps because not enough trees are averaged, and therefore the averages do not indicate any particular effect on size in plats 4 to 7 as compared with 1 and 3, except in the Winesaps where the size decreased as the DDT was increased. The fruit of all varieties sprayed with 6 oz. of DDT and 1 lb. of xanthone (7) was just as large as that sprayed with lead arsenate (1), and in two of the varieties it was larger than fruit sprayed with xanthone alone (3). Practically the same thing is true of the fruit sprayed with 2 oz. of DDT and 1-1/2 lbs. of xanthone (6). Jonathans and Winesaps in plat 8 were smaller than those in 7, and yet, except for the calyx spray, the treatment was the same, indicating inadequacy in the number of trees used for determining size of fruit.

The color improves as the DDT is decreased (table 4) and the xanthone increased, and yet again there are differences between plats 7 and 8 not explainable by the treatment.

Omitting the calyx spray, as in plat 8, did not increase the infestation. Omitting every other cover spray, as in 9, however, did increase it, on the average, though not very much. It should be noted, however, that the Winesaps in this treatment were the smallest of any, and the color was poor, indicating that xanthone at such infrequent intervals is inadequate for controlling mites.

In plat 10, DN-111 was added once to the DDT on the Jonathans and Romes and twice on the Winesaps. Mite control was poor, as shown by the size and color of the fruit. In plat 11, the use of 3 qts. of oil in the last three sprays resulted in the smallest apples and the poorest color of any of the treatments. Mites were controlled as long as sprays were applied, but a heavy infestation developed later.

Conclusions from these tests are that xanthone may be used successfully with DDT for controlling the mites and that only a minimum quantity of DDT is needed, 2 to 4 oz., in this combination for excellent control of the codling moth. This is in a schedule of 5 or 6 applications. Indications are that 2 or 3 applications would not control the mites, and with mites developing late in the

season, as they did in 1946, an additional application of xanthone or perhaps of DN-111 about the middle of August would improve control of them. The mites increased less, after spraying was discontinued, where xanthone was used than where DN was used, although the latter had not been applied as many times. Probably a pound of xanthone or a little more, with not over 4 oz. of DDT would be as good a combination as any.

The woolly aphis developed to a considerable extent in trees sprayed with DDT alone, as in plat 10, but a single application of nicotine sulfate with the last spray controlled it. There was only a minimum development of it in the trees sprayed with xanthone or the DDT-xanthone combinations, although it was more common in trees sprayed with the least xanthone. Incidentally, there was evidence that the DDT-xanthone combination prevented much development of the rosy aphis.

Detailed results of the other treatments are not given as they were used on only a few trees. Indications were that 6 lbs. of benzene hexachloride containing 5% of the gamma isomer would be needed to control the codling moth better than lead arsenate. This did not prevent the development of mites but there were no woolly aphids on the trees. Winesaps from these trees were sampled by more than a dozen people who did not know what they had been sprayed with. Most of them did not notice a slight musty taste until after it was brought to their attention, and some of them thought this taste was similar to that often found in apples that have been in storage for a time.

Use of Sprays to Kill Hibernating Codling Moth Larvae on Apple Tree Trunks

Large-scale orchard tests were made in two orchards in 1946. Orchard A, which has been used for similar tests for 4 years, consisted of 13 rows as follows: four west rows and 5 east rows of Winesaps with 4 rows of Jonathans in between. The plats were laid out across these as follows: the north 13 rows were sprayed with the regular DNOC formula containing a penetrant. The south 16 rows were sprayed with the quick-breaking formula with the Celite penetrant aid, and the middle 6 rows between these two plats were left as a check. In orchard B, consisting of medium-sized Romes, the south 15 rows were sprayed with the regular penetrant formula and the north 7 rows were left as a check.

All sprays were applied March 20-27, using a regular gasoline power sprayer equipped with spray rods and Vermorel-type nozzles to which were attached spray stream deflectors to narrow the spray stream and direct it downward. Sprays were applied at approximately 175 pounds pressure. Approximately 5 gallons of spray were used per tree on the large trees in orchard A, and 1.6 gallons on the medium-sized Romes in orchard B. In the latter there was very little rough bark above 4 or 5 feet. Examination of 1505 larvae in orchard A about 20 days after the sprays were applied showed an

accumulated kill of 99 percent in the regular DNOC formula plat, 96 percent in the DNOC-Celite plat and 58 percent in the check. A portion of the dead in the sprayed plats were left over from previous sprayings while practically all of those found in the check had been killed by trunk spray applied in 1944.

In orchard B, which had not previously had a trunk spray, there was a kill of 89 percent in the sprayed plat and none in the check. The results of harvested fruit examination are shown below.

Orchard	Treatment	Percent wormy fruit		
		Jonathans	Winesaps	Romes
A	Regular DNOC formula with a penetrant	5.8	3.9	
	Revised DNOC formula with Celite penetrant aid	15.7	3.8	
	Check	11.8	6.0	
B	Regular DNOC formula with penetrant			3.8
	Check			11.2

The regular formula in orchard A appears to have given some additional control as compared with the check in both Jonathans and Winesaps. It appeared better than the revised formula on Jonathans but about the same on Winesaps. In orchard B there was a distinct control for the regular trunk spray formula as compared with the check.

As usual where it is necessary to leave check plats in codling moth control experiments such as these, if the moths remained in the check instead of migrating into the treated plats the checks would be more infested than they are and the treated plats less. This, obviously, would result in a greater difference between treated and check plats in favor of treatments.

The codling moth population in some of these plats was also checked by recording the number of empty pupal cases found semi-weekly on four trees in each plat. The total number on four treated trees in orchard B was 85 and on four check trees 571. The number of moths caught in four baits in each of these plats was 2,785 and 3,716, respectively. Thus, the record of pupal cases comes nearer showing the actual difference in the two plats than does the bait record.

Summer Trunk Spray Test:- For the third season a test was made of the use of trunk sprays in the summer. Four formulas were applied on July 16, as follows: the regular DNOC formula with a penetrant, the same made up in a paste before dilution, the quick-breaking formula with Celite as a penetrant aid, and the quick-breaking formula without Celite. Three trees, mostly Newtowns, were used for each formula, and three additional trees were left unsprayed as a check. Only trees without a crop were used. Adhesive bands were applied to the scaffold limbs at the upper limits of the spray to prevent escape of larvae in that direction. All visible old empty pupal cases were removed. On July 17 and 23, full-grown larvae were placed on 12 of these sprayed trees and on 3 unsprayed checks. Semi-weekly examinations were made of the sprayed surfaces and the checks for dead and live individuals and empty pupal cases. On August 28 a final examination was made which showed a kill of 66 percent for both the regular DNOC formula and the same prepared as a paste. The DNOC-Celite formula and the quick-breaking formula gave kills of 62 and 35 percent, respectively. The check showed 30 percent dead.

On August 20, full-grown larvae were placed on the other 3 trees of each formula sprayed on July 16, and on 3 checks. These were examined semi-weekly until moth emergence stopped and finally, after 41 to 46 days, on October 2 to 7. The regular DNOC formula showed 46 percent dead; DNOC with Celite, 34 percent; quick-breaking without Celite, 35 percent; the DNOC regular formula prepared as a paste, 24 percent; and the check, 6 percent. This test indicated considerable kill for the better formulas but not as great as in previous tests.

Table 1.--Average spray residues in micrograms per square centimeter, and residue at harvest in parts per million. Yakima, Wash., 1946.

Treatment No. 1/	Residue	Jonathan Before spray mg./sq. cm.	Jonathan After spray mg./sq. cm.	Jonathan Harvest p.p.m.	Rome Before spray mg./sq. cm.	Rome After spray mg./sq. cm.	Rome Harvest p.p.m.	Winesap Before spray mg./sq. cm.	Winesap After spray mg./sq. cm.	Winesap Harvest p.p.m.
1	As_2O_3	11.9	25.1		13.0	29.0		19.5	37.1	
2	As_2O_3	9.0	14.7		--	--		--	--	
	DDT	6.5	8.1	4.9	--	--		--	--	
3	Xanthone	3.4	25.4		9.4	36.1		9.6	28.0	
4	Xanthone	0.9	5.8		2.2	10.3		1.9	10.6	
	DDT	5.1	8.3	2.9	5.4	11.1	2.1	5.3	8.9	2.1
5	Xanthone	2.1	13.9		3.5	17.9		4.6	21.5	
	DDT	3.6	7.0	1.9	3.9	8.3	1.2	4.1	6.1	-
6	Xanthone	3.5	20.8		8.4	31.8		6.8	29.7	
	DDT	3.4	5.2	1.0	3.4	7.3	0.5	2.8	4.7	1.0
7	Xanthone	2.2	15.3		5.3	21.9		4.3	11.0	
	DDT	4.2	8.7	2.5	5.4	9.4	2.0	5.0	6.7	1.6
9	Xanthone	1.6	10.4		2.2	18.8		-	-	
	DDT	2.0	5.1	1.6	2.6	8.0	1.0	-	-	2.0
10	DDT	-	-	-	5.4	12.1	1.6	9.6	15.3	3.8
11	DDT	-	-	-	-	-	4.0			-

1/ For details of treatment, see table 2.

Table 2.--Comparative efficiency of insecticides used in field spraying experiments. Yakima, Wash., 1946.

No.	Treatment (quantities are for 100 gallons)[1]	Orchard A Jonathan		Orchard B Rome		Orchard C Winesap	
		% wormy	% injured	% wormy	% injured	% wormy	% injured
1.	Lead arsenate 3 lbs., mineral oil (emuls.) 1 qt.[2] Colloidal 77, 1/6 lb.	7.6	10.8	6.2	11.4	13.7	41.7
2.	DDT 4 oz.,[3] lead arsenate 1-1/2 lb., oil and spreader as in 1[4]	1.6	3.0				
3.	Xanthone (Genicide) 2 lb., stove oil 1/3 qt., Colloidal 77 spreader 1/12 lb.[5]	5.1	6.6	6.8	9.3	20.6	31.5
4.	DDT 6 oz., xanthone 1/2 lb., stove oil and spreader as in 3[6]	1.4	2.4	1.0	2.4	2.6	10.1
5.	DDT 4 oz., xanthone 1 lb., stove oil and spreader as in 3[6]	3.7	5.5	1.8	3.6	3.8	10.0
6.	DDT 2 oz., xanthone 1-1/2 lb., stove oil and spreader as in 3[6]	4.1	5.5	3.0	4.2	7.6	15.1
7.	DDT 6 oz., xanthone 1 lb., stove oil and spreader as in 3[6]	1.5	2.7	.7	2.1	3.1	10.2
8.	Same as 7; no calyx spray	1.9	2.6	1.0	2.3	2.0	7.7
9.	Same as 7; 2d, 4th and 6th cover sprays omitted	2.2	3.8	1.6	2.9	2.7	11.8

Table 2.--(Cont.)

No.	Treatment (quantities are for 100 gallons)1/	Orchard A Jonathan % wormy	Orchard A Jonathan % injured	Orchard B Rome % wormy	Orchard B Rome % injured	Orchard C Winesap % wormy	Orchard C Winesap % injured
10.	DDT 8 oz.,4/ DN-111 1/3 lb. with 4th cover in both orchards, and 1/4 lb. with 6th cover in Winesaps			1.4	2.9	2.9	9.8
11.	DDT 4 oz., mineral oil (emulsible) 3 qt.7/			1.7	4.0		
	Differences required for significance (19:1)	5.2	4.2	2.9	4.3	4.1	6.6

1/ Calyx spray, lead arsenate 2 lb. to 100 gal. in all treatments except No. 8.
2/ 2 qt. in 2d cover spray.
3/ Actual DDT. In all cases where DDT was used it was 50% Deenate.
4/ 3/4 pt. nicotine sulfate to 100 gal. added to 5th cover on Jonathan and Rome.
5/ Jonathans sprayed as in 1, 1st and 2d covers. Stove oil used at 1 qt. and Colloidal 77 at 1/2 lb. with Xanthone in 1st and 2d covers on Romes and Winesaps.
6/ Jonathans sprayed as in 10, 1st and 2d covers.
7/ 1 qt. of oil in 1st cover and 2 qt. in 2d.

Table 3.--Size of apples resulting from spray treatments and percentage of dropped fruit. Yakima, Wash., 1946.

Plot	Treatment[1]	Size (ave. no. apples per orchard box)				% fruit dropped		
		Jonathan	Rome	Winesap	Average	Jonathan	Rome	Winesap
1.	Lead arsenate 3 lbs.	105	88	110	101	13	2	2
2.	DDT-lead arsenate	105	--		-	22	-	-
3.	Xanthone 2 lbs.	111	83	121	105	4	2	8
4.	DDT 6 oz., xanthone 1/2 lb.	110	85	123	106	6	1	2
5.	DDT 4 oz., xanthone 1 lb.	107	82	120	103	5	1	4
6.	DDT 2 oz., xanthone 1-1/2 lb.	113	90	110	104	4	1	4
7.	DDT 6 oz., xanthone 1 lb.	102	88	110	100	6	1	2
8.	Same as 7, no calyx spray	110	84	119	104	5	1	1
9.	Same as 7, alternate sprays omitted	110	84	129	108	6	1	3
10.	DDT 8 oz., DN-111	-	88	128	-	-	1	1
11.	DDT 4 oz., mineral oil 3 qts.	-	103	-	-	-	2	-

1/ For details of treatment, see table 2.

Table 4.--Percentage of extra fancy fruit resulting from spray treatments. Yakima, Wash., 1946.

Plot	Treatment 1/	% extra fancy fruit			
		Jonathan	Rome	Winesap	Average
1.	Lead arsenate 3 lbs.	43	36	54	44
2.	DDT-lead arsenate	42	--	--	--
3.	Xanthone 2 lbs.	61	52	49	54
4.	DDT 6 oz., xanthone 1/2 lb.	39	37	34	37
5.	DDT 4 oz., xanthone 1 lb.	47	40	37	41
6.	DDT 2 oz., xanthone 1-1/2 lb.	40	48	43	44
7.	DDT 6 oz., xanthone 1 lb.	47	40	42	43
8.	Same as 7, no calyx spray	51	33	36	40
9.	Same as 7, alternate sprays omitted	39	28	39	35
10.	DDT 8 oz., DN-111	--	28	40	--
11.	DDT 4 oz., mineral oil 3 qts.	--	15	--	--

1/ For details of treatment, see table 2.

KEARNEYSVILLE, WEST VIRGINIA

James F. Cooper, Bureau of Entomology and Plant Quarantine,
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West Virginia Agricultural Experiment Station.

These investigations were carried on jointly by the Bureau of Entomology and Plant Quarantine and the West Virginia Agricultural Experiment Station.

Seasonal Conditions and Codling Moth Activity

Temperatures averaging above normal each of the first four months of 1946 accelerated fruit bud development. By April 2 peaches were in full bloom and apple buds were in the prepink stage. A cool period from April 6 through 15 slowed development so that apples did not reach full bloom until April 18. Low temperatures on April 11 resulted in heavy killing of peaches and Delicious apple buds in scattered locations and a light kill of the buds of other apple varieties.

Codling moth carry-over from 1945 was relatively light. Pupation was first observed on March 25 and amounted to 10 percent by March 29. However first emergence of adults was not noted until April 20. The peak period of adult codling moth activity occurred between May 6 and 25, with the peak bait pail collection on May 11. Cool rainy weather during late July and August was likewise unfavorable for second brood development. This situation coupled with widespread use of DDT throughout this area resulted in an exceptionally clean crop insofar as codling moth injury was concerned.

The most serious apple insect damage in 1946 was inflicted by the red-banded leaf roller. Fruit injury by this insect ran as high as 35 to 40 percent in a few orchards and was quite general throughout the area, probably averaging 5 percent.

European red mite (Paratetranychus pilosus) and red spiders (Tetranychus spp.) were present in varying numbers in most orchards of the area. While no serious defoliation was noted, considerable commercial damage was inflicted through lowered foliage efficiency and tree vigor. The peak of mite populations was reached late in July and persisted through mid-August.

Field Tests of Insecticides

A 40-acre orchard located a few miles sough of Martinsburg, Berkeley County, West Virginia was used for most of the 1946 field testing. This orchard was divided into four blocks, Block A, consisting of York interplanted with Transparent, was used for testing concentrated spray formulations, Blocks B and C, consisting of Stayman interplanted with Transparent and Williams Early Red, were used primarily for tests of miticidal materials and schedules and Block D, consisting of

Grimes, was used for tests of DDT schedules and formulations and some of the other newer insecticides. The codling moth carry-over in this orchard was probably as heavy as in any orchard in this area due to neglect for some years previous to 1946. Even so, the high degree of control obtained with practically any DDT dosage or schedule under prevailing weather conditions rendered the crop so clean that significant differences between treatments were few.

This orchard was nitrated early in March to build up vigor. A delayed dormant spray of 4 percent oil plus 0.5 percent of tar oil (83%) was applied on March 22, the pink spray of liquid lime sulfur 2:100 on April 6 and the petal fall spray on May 2-3 of 10 pounds flotation sulfur, 3 pounds of lime and 3 pounds of lead arsenate per 100 gallons. The above were all applied with a conventional power sprayer using two 8-nozzle broom type guns, one from the ground and one from the tower. Treatment differentiation began with the first cover application. Five cover sprays were applied to Block A (Plots 1-39) and to plots 54 and 55 in Block C. Plot 61 in Block C received only three cover sprays. Four cover sprays were applied to all other plots in Block C and to all plots in Blocks B and D. Spraying of Transparents in Block A was discontinued after the third cover and of the Transparents and Williams Early Red in Blocks B and C after the second cover spray. Dates of the five cover sprays were: May 22-25, June 3-10, June 17-22, July 1-4, and July 26-27. Infestation records were taken at harvest in July for the Transparent and the Williams Early Red varieties, but are not included in the tables.

Data presented in the following tables regarding mites do not differentiate as to species. European red mite (Paratetranychus pilosus) and two species of red spider mites (Tetranychus bimaculatus and T. schoenei) were present in practically all collections. During the periods covered in the tables populations of Paratetranychus and Tetranychus were about equal in numbers.

Block A - Application of Concentrates: Exploratory tests were conducted using liquid concentrates applied by means of a Bean "Double Mist Duster." This machine is equipped with two paddle type blowers fitted with fishtail outlet nozzles. For application of dry dusts the material is fed from the hopper into the fan housing and blown out through the fishtail nozzles. For application of liquids the material is fed from the tank to jets located in the mouth of the fishtail nozzles under low pressure (10 to 30 pounds per square inch) by means of a rotary pump and atomized by the air blast, which has a velocity of approximately 120 miles per hour at the nozzle. Each fan displaces approximately 8,000 cubic feet of air per minute. The position of the two blowers is adjustable so that both may be directed to the same side of the machine or they may be directed to opposite sides. In order to insure adequate coverage of the apple trees both nozzles were turned to the same side in our tests with their horizontal angles varied slightly to increase the horizontal spread of the air blast and give complete coverage of the tree from base to top. Only liquid materials were used in these tests.

Formulations used were principally water emulsions of DDT solutions. Two plots were set up using DDT dissolved in oil, but foliage injury was so severe that they were discontinued after two covers. The basic formula was 2 ounces of DDT dissolved in 5 ounces of solvent (benzene or xylol) and emulsified with 5 cc. emulsifier and water to make one gallon. The standard dosage was one gallon of emulsion per tree per application. Plot 1, a standard for comparison, was sprayed with the power sprayer with 1/2 pound of DDT per 100 gallons, using approximately 25 gallons per tree per application. The water in oil emulsion tested (plot 26) was difficult to prepare and use, being constantly on the verge of breaking.

The table for Yorks following gives the results of tests of this method of applying concentrates. Mite data are presented as a matter of interest.

TEST OF MIST SPRAYS - BUTLER ORCHARD - BERKELEY COUNTY, W. VA. - 1946
Block A - York - 5 Covers - Two Replicates per Treatment

Plot No.	Materials (Per gal.--1 gal. per tree except as noted)	Codling Moth Infestation 1st Br. % inj. fruit	Season % inj. fruit	Per 100 Fr. Worms	Per 100 Fr. Stings	Mites per 100 Leaves on 7/18	8/6	8/20
1	1/2 lb. per 100 gal. @ 25 gal. per tree (regular power sprayed)	0.8	5.1	0.4	5.5	3208	5992	5088
2	1 oz. DDT-benzene emulsion	6.5	14.2	3.8	13.2	164	1568	1696
3	2 oz. DDT-benzene emulsion	0.8	13.1	2.2	13.1	352	1765	3190
4	4 oz. DDT-benzene emulsion	1.5	6.6	2.1	6.1	89	1566	3768
5	2 oz. DDT-xylol emulsion	9.5	13.1	7.4	9.7	1608	2144	3936
6	4 oz. DDT-xylol emulsion	4.5	11.0	4.4	9.3	56	1600	1792
7	2 oz. DDT-benzene emulsion @ 2 gal. per tree	7.5	12.9	5.2	12.2	892	2168	816
8	2 oz. DDT-benzene emulsion (double amt. benzene as 3)	3.5	7.5	1.2	8.2	28	328	2712
9	2 oz. DDT-xylol emulsion (double amt. xylol as 5)	8.5	23.0	11.4	24.6	328	1936	2608
10	2 oz. DDT-benzene emulsion (triple amt. benzene as 3)	5.2	13.8	5.6	12.6	108	1169	2856
11	2 oz. DDT-benzene emulsion (1/2 gal. per tree)	13.7	38.0	33.0	33.5	904	1106	1312
12	2 oz. DDT-benzene-oil A emulsion	3.2	5.8	2.8	4.9	168	1048	1704
13	2 oz. DDT-benzene-oil B emulsion	3.5	10.9	5.2	9.3	204	1480	1424
14	2 oz. DDT-benzene-kerosene emulsion	5.5	13.7	6.1	13.6	412	3984	6624
15	2 oz. DDT-benzene-kerosene-oil A emulsion	7.5	8.8	2.3	9.5	365	2304	4974
22	Same as 15 plus 5 gm. aluminum stearate	4.2	7.2	1.4	7.2	1172	2940	2130
16	2 oz. DDT-benzene kerosene-oil B emulsion	6.2	14.6	6.0	13.4	160	1248	1696
28	Same as 16 plus 5 gm. aluminum stearate	6.0	9.6	3.6	8.8	472	1800	3360

BLOCK A (Continued)

Plot No.	Materials (Per gal.—1 gal. per tree except as noted)	Codling Moth Infestation 1st Br. % inj. fruit	Season % inj. fruit	Per 100 Fr. Worms	Per 100 Fr. Stings	Mites per 100 Leaves on 7/18	8/6	8/20
17	1/2 pt. Ryania extract	6.5	6.9	1.0	8.0	88	2124	896
18	2 oz. DDT-Velsicol emulsion	8.7	12.1	5.1	9.5	264	2004	4216
19	2 oz. DDT-tetralin emulsion	5.7	12.7	1.9	11.9	456	2166	2520
20	2 oz. DDT-cyclohex. emulsion	4.7	17.2	10.0	15.7	88	1212	3488
21	Same as 5 @ 10 lb. pressure	8.2	17.2	15.2	12.4	480	1760	1996
23	2 oz. DDT-xylol-oil A-emulsion (oil in water)	6.2	14.8	7.4	13.1	684	1936	1328
26	Same as 23 but water in oil emulsion	2.7	12.1	2.2	12.2	168	1136	896
24	Same as 5 except with X-100 as emulsifier	4.7	8.6	1.0	9.0	392	1004	1776
25	Same as 5 except with B-1956 as emulsifier	5.2	21.5	10.2	21.5	886	3396	1104
27	6.7 oz. "Liquid 30"	7.2	18.7	8.0	17.5	204	1424	1868
29	8 oz. "Syndeet"	3.7	15.9	8.8	13.3	428	1372	1192
30	1945 DDT-1946 xylol emulsion	5.0	9.5	1.8	8.8	1720	1482	4840
34	'45 DDT- '45 xylol emulsion	6.0	13.1	5.9	11.8	312	1136	4528
31	'45 DDT- '46 benzene emul.	4.5	13.0	4.4	13.9	508	3408	1352
32	'45 DDT- '45 benzene emul.	2.7	5.4	1.3	4.9	396	1732	2648
33	'46 DDT- '45 benzene emul.	6.2	17.8	14.8	12.2	368	920	1290
35	Same as 5 except jets set at 160° angle	3.0	13.4	4.8	11.2	512	4344	1748
37	Same as 5 except jets set at 135° angle	4.0	13.3	2.6	13.0	0	2368	6216
36	Same as 5 except only one nozzle used	11.2	17.7	15.4	16.3	372	2456	1128

Blocks B and C - Stayman. No sprays were applied in Block B for second brood codling moth control. A fifth cover spray was applied to Plots 54 and 55 in Block C based on the five-cover spray program suggested in case first-brood codling moth control should appear inadequate The 22 plots in these blocks were set up primarily to test mite control or mite retardant materials and their effect on codling moth control schedules and on the fruit and foliage. In Block B the spray schedule was the same for all plots except for the addition of possible miticides in one or more covers. In Block C some variation in schedules occurred to test schedules as well as materials in codling moth and mite control. A lead arsenate plot (Plot 51) was included for comparison. Plots 40, 41 and 52 were the standard four-cover DDT schedule suggested for use in this area in 1946. The results obtained in Blocks B and C are summarized in tables following.

No significant differences in codling moth control was noted between any of the DDT plots in either block. All DDT plots were cleaner than the lead arsenate plot, which had only 6.3 percent injured fruit with 6.9 worms per 100 apples. The three-cover DDT schedule (Plot 61) was as effective as the four and five-cover schedules.

No mites were found in samples collected from the plots on June 12 and June 20. Populations found in the samples taken on July 18, August 6 and August 20 are shown in the tables. The differences in mite populations found between plots varied considerably and it is questionable that significance can be attached to the results. The mite population present on August 20 on the lead arsenate plot was exceeded by only one of the 21 DDT plots. The lowest mite population found on that date was on Plot 48 where DN-C-454 had been used in two cover sprays. The lime sulfur plots (56 and 57) showed a stunting of foliage.

Block D - Grimes. No second brood sprays were applied to this block. Codling moth control in all plots except one was satisfactory with differences between plots hardly significant with this one exception. The table for Block D following indicates the codling moth and mite infestations. Eight pounds of flotation sulfur was used in the first cover and a 2-4 Bordeaux in the 4th as fungicides in plots in which fungicides are indicated.

A comparison between three degrees of fineness of DDT (Plots 82, 83 and 84) shows little difference between the fine and coarse micronized materials but the coarse ball milled material was significantly less efficient.

Most of the emulsions were satisfactory, the poorest being one in which kerosene and a horticultural base oil had been added to the basic DDT-benzene solution. Cyclohexanone (Plot 95) was the least effective solvent tested, as it was in the mist spray series (Block A). Velsicol 1068 was also among the less effective materials. Ground Ryanex (Plot 85) had fewer worms than any plot except the oil-DDT schedule (Plot 80) and the oil-DDT schedule caused serious defoliation.

The study of mite populations in conjunction with the codling moth schedules was inconclusive. The lowest population on August 20 was in the plots of Ryanex and Velsicol 1068.

SPRAY TESTS - BUTLER ORCHARD - BERKELEY COUNTY, W. VA. - 1946

Block B--Stayman - Four Cover Sprays, Five Replicates per Treatment

Plot No.	Materials (Amounts per 100 gal.)	Codling Moth Infestation 1st Br. % inj. fruit	Season % inj. fruit	Season Per 100 Fr. Worms	Season Per 100 Fr. Stings	Mites per 100 Leaves on 7/18	8/6	8/20
40	1st-8#FS, 1# DDT 2 & 3 - 3/4# DDT 4th-2-4 Bordo. 1# DDT	0.1	1.0	0.4	0.7	22	65	1720
41	Same as 40	0.0	0.8	0.6	0.4	17	96	760
42	Same as 40 plus 6 qt. oil in 3rd.	0.2	1.5	0.6	0.9	9	135	1676
43	Same as 40 plus 6 qt. oil in 4th	0.7	1.0	0.3	0.7	104	112	1232
44	Same as 40 plus 6 qt. oil in 3 & 4	0.1	0.6	0.1	0.4	26	36	808
45	Same as 40 plus 1# xanthone in 2 & 3	0.0	1.2	1.0	0.5	111	28	836
46	Same as 40 plus 1 1/4# DN-111 in 2 & 3	0.9	0.8	0.4	0.5	13	80	856
47	Same as 40 plus 5# flavan in 2nd 4# flavan in 3rd	0.1	1.0	0.4	0.7	9	193	1100
48	Same as 40 plus 1 1/4# DN-C-454 in 2 & 3	0.4	2.1	1.0	1.3	11	40	344
49	Same as 40 plus 1 qt. Dithane in 2 & 3	0.1	0.6	0.4	0.3	20	292	1224
50	Same as 40 plus 8# flavan in 2 & 3	0.5	1.2	0.5	0.8	13	176	1712

SPRAY TESTS - BUTLER ORCHARD - BERKELEY COUNTY, W. VA. - 1946
Block C--Stayman - Four Cover Sprays, Five Replicates per Treatment

Plot No.	Cover Sprays	Materials (Amounts per 100 gal.)	Codling Moth Infestation 1st Br. % inj. fruit	% inj. fruit	Season Per 100 Fr. Worms	Stings	Mites per 100 Leaves on 7/18	8/6	8/20
51	1st 2&3 4th	8#FS, 3#Li, 3#LA 1/2-2 Bordo. 3#LA 2-4 Bordo. 3# LA	3.8	6.3	6.9	4.1	55	330	2624
52	1st 2&3 4th	8#FS, 1#DDT 3/4# DDT 2-4 Bordo, 1#DDT	0.0	0.7	0.3	0.5	23	46	1720
53	1st 2&3 4th	8#FS, 3/4#DDT 1/2#DDT 2-4 Bordo., 3/4# DDT	0.3	0.6	0.4	0.4	11	392	1252
54	1st 2&4 3&5	8#FS, 1#DDT 3/4#DDT 2-4 Bordo. 3/4#DDT	0.0	0.6	0.1	0.6	36	448	2282
55	1st 2&4 3&5	8#FS, 1#DDT 1 1/4# DN-111, 3/4#DDT 2-4 Bordo, 3/4#DDT	0.1	0.7	0.4	0.4	13	108	1872
56	1st 2&3 4th	1 gal.LS, 1/2# soap, 1#DDT 1 gal.LS, 1/2# soap, 3/4#DDT 2-4 Bordo, 1#DDT	0.1	1.0	0.9	0.3	8	244	2016
57	1st 2&3 4th	8#FS, 1#DDT 1 gal.LS, 1/2#soap, 3/4#DDT 2-4 Bordo., 1#DDT	0.0	1.0	0.6	0.6	11	92	2192
58	1st 2&3 4th	1/2# soap, 1#DDT 1/2# soap, 3/4#DDT 2-4 Bordo., 1#DDT	0.0	0.9	0.7	0.4	10	172	968
59	1st 2&3 4th	8#FS, 1#DDT 5# DDT-flavan mix. 2-4 Bordo., 1#DDT	0.1	1.1	0.5	0.6	40	924	4406
60	1st 2nd 3rd 4th	8#FS, 1#DDT 2-4 Bordo, 3/4#DDT 3/4# DDT 2-4 Bordo., 1#DDT	0.1	0.9	0.9	0.5	4	84	1904
61	1st 2nd 3rd	8#FS, 1#DDT 1#DDT 2-4 Bordo., 1#DDT	0.2	1.2	0.8	0.8	103	544	2312
62	1st 2nd 3rd 4th	8#FS, 1#DDT 8#FS, 3/4#DDT 3/4#DDT 2-4 Bordo., 1#DDT	0.7	0.9	0.3	0.6	15	280	928

SPRAY TESTS - BUTLER ORCHARD - BERKELEY COUNTY, W. VA. - 1946
Block D--Grimes - Four Cover Sprays, Five Replicates per Treatment

Plot No.	Materials (Amounts per 100 gal.)	Codling Moth Infestation 1st Br. % inj. fruit	Season % inj. fruit	Season Per 100 Fr. Worms	Season Per 100 Fr. Stings	Mites per 100 Leaves on 7/18	8/6	8/20
79	1/2# DDT(CS) with fung.	0.7	1.6	1.3	0.5	52	508	1504
80	1st cov., 1#DDT(CS) + 1 qt. oil D 2nd & 3rd cov., 3/4#DDT(CS) + 3 qt.oil D 4th cov., 1#DDT(CS) + 1 qt. oil K	0.1	0.5	0.01	0.5	76	184	1384
81	1/2# DDT (duP) with fung.	0.3	1.2	1.1	0.1	52	776	1848
100	1/2# DDT (duP) without fung.	1.3	1.5	1.6	0.1	136	1574	1384
82	.4# DDT (fine) with fung.	0.5	2.7	2.9	0.3	76	984	1320
83	.4# DDT (medium) with fung.	0.3	3.2	2.0	1.4	58	664	960
84	.4# DDT (coarse) with fung.	8.6	19.5	30.6	1.6	170	736	1296
	NO FUNGICIDES IN PLOTS 85-99							
85	6 1/2# ground Ryanex	0.4	3.0	0.02	3.1	28	210	392
86	1/2# 1068-xylol emulsion	3.7	7.4	9.2	1.1	124	744	304
87	1 pt. "Snydeet"	2.9	5.1	4.0	1.7	24	992	1364
88	1# di(methoxyphenyl)-trichloroethane	0.4	1.7	1.8	0.3	104	680	1064
89	1 qt. "liquid 30"(30%DDT)	0.7	2.6	2.4	0.8	20	1416	2028
90	1/2# DDT-benzene-kerosene-oil K emulsion	3.1	6.3	8.6	1.4	44	960	1240
91	Same as 90 + 2 oz. aluminum stearate	1.3	2.7	2.0	0.8	48	492	1512
92	1/2# DDT-benzene emulsion	1.1	1.7	1.0	1.0	24	638	646
93	1/2# DDT-xylol emulsion	1.8	1.4	1.7	0.04	20	576	1160
94	1/2# DDT-Velsicol emulsion	1.1	3.4	2.3	1.2	52	1346	1520
95	1/2# DDT-cyclohexanone emul.	3.5	4.9	5.8	0.9	160	1520	880
96	1/2# DDT-tetralin emulsion	2.6	3.2	2.5	1.1	8	560	1392
97	1/2# DDT-benzene-kerosene emul.	1.1	4.1	3.2	1.9	28	982	568
98	1/2# DDT-benzene-oil K emul.	0.9	4.2	2.8	1.8	28	600	736
99	1/2# DDT-benzene-oil A emul.	1.5	2.5	2.7	0.2	32	1152	784

Tests of Dust for Codling Moth Control

A four-acre block on the Station grounds was used for testing dusts for codling moth control. This block consisted of 6 rows of Red Romes and 3 rows of Starking Delicious, 14 trees to the row. The east 4 rows, one Delicious and three Rome, received 4 first brood cover sprays applied with a conventional orchard sprayer. The west five rows, two Delicious and three Rome, were subdivided into three segments, each segment receiving one of the dust treatments. Five applications were made; four first brood and one second brood.

The same dust composition was used for each treatment; one plot received the dry dust, one received the dust wet with water, and one received it wet with water containing a sticker consisting of 4 ounces soybean oil emulsified with one ounce of B-1956 per 100 gallons. The dust was applied at the rate of 2 1/2 pounds per tree per application. Water and the water containing the sticker solution were used at the rate of one quart per pound of dust.

The duster was a Bean "Mist Duster" with 2 fishtail outlet nozzles, both directed toward the same side of the machine but at slightly different vertical angles to increase the spread to cover the tree from top to bottom more adequately than could be done with only one nozzle. Fourteen jets in the mouth of each nozzle injected the liquid into the dust stream for wetting.

Schedules and results were as follows:

Spray:	1st cover	8 lb. flotation sulfur, 1 lb. DDT
	2nd and 3rd covers	3/4 lb. DDT
	4th cover	2-4 Bordeaux, 1 lb. DDT
Dust:	1st cover	40% micronized sulfur, 8% DDT, 52% talc
	2nd and 3rd covers	40% micronized sulfur, 5% DDT, 55% talc
	4th and 5th covers	5% DDT, 95% talc.

Treatment:	Codling moth infestation counts			
	1st Brood	Season		
	% injured fruit	% injured fruit	Per 100 fruits Worms	Per 100 fruits Stings
Spray	0.29	1.39	0.66	0.85
Dry dust	0.27	0.21	0.12	0.11
Dust-water	0.07	0.42	0.11	0.33
Dust-sticker	0.06	0.48	0.07	0.43

VINCENNES, INDIANA

L. F. Steiner, In Charge 1/

Seasonal Conditions and Codling Moth Development

During the six-month period from April to September inclusive, rainfall amounted to 22.10 inches or about 5 percent less than normal, being more than 100 percent above normal in May and slightly below normal in the other five months. Mean daily temperatures during the same period averaged about 2 1/2 degree below normal, being about 5.4 degrees below normal in August and about 3.1 degrees above normal in April. Frosts reduced the crop somewhat in May but wide-spread use of DDT along with the unfavorable conditions for codling moth development resulted in the production of a very high percentage of sound fruit.

Most varieties were ready for the calyx spray between April 4 and 10. Codling moth emergence began April 9, the earliest record for this area and three weeks ahead of normal. Trap catches indicated that the first main peak of activity occurred April 21 to 23. The first hatch occurred May 5. The rate of moth emergence, egg deposition, and development was very slow during May with emergence not more than 30 percent complete at the beginning of the month and 70 percent at the end and with the incubation period still 14 days or longer as late as June 5. Between June 5 and 12 the incubation period shortened to six or seven days, a second peak of moth activity occurred (June 7 to 8) and the heaviest first-brood hatch of the season followed during the week of June 16. Moth emergence in local orchards was 99 percent complete by June 18. First-brood worms began leaving apples not later than June 15 and first-brood adults were emerging by June 26. In Vincennes, temperatures exceeded 90° on only five days in July and two days in August. The maximum temperature was less than 80° F. on 16 days in July and August and on 14 days in September. Codling moth development was slow throughout July, August and September and the control obtained by growers was unusually good. Almost no third-brood attack was observed in this area and the carry-over of hibernating worms is the lowest that has occurred in more than 10 years.

The following data illustrate the average effect of differences in the seasonal conditions on codling moth control obtained with treatments applied to three varieties in a local orchard during each of the past three years. No supplemental control measures were used between the seasons indicated.

1/ The chemical analyses and particle size determinations reported herein were made by J. E. Fahey, Division of Insecticide Investigations. Except for factory-processed materials Mr. Fahey prepared most of the DDT formulations used in the 1946 experiments in accordance with specifications suggested by tests in previous years.

Treatment	Percent Wormy Apples 1944	1945	1946
Lead arsenate, bordeaux, oil	68	14	11.7
Tank mix nicotine bentonite, oil	28	9	2.4
DDT	13	2	0.9

Number regular cover sprays: 10 in 1944, 7 in 1945, 6 or 7 in 1946. Lead arsenate plots were given one extra (10-day) cover spray each year.

Some credit must be given in 1946 to the low carry-over of codling moth larvae from 1945.

Laboratory Experiments with Insecticides

Ovicidal Tests

Codling moths were allowed to deposit their eggs on Golden Delicious apples previously washed in acetone to remove excess wax. A total of 13,152 eggs of three ages was sprayed with several mixtures of DDT in oil or in xylene or with nicotine bentonite and oil. Results indicate that the combination of DDT and oil either as an emulsified solution or as a water wettable powder and oil mixture will not result in a higher ovicidal efficiency than obtained from oil alone. In these tests, best results were obtained with the combination of nicotine bentonite, DDT, and 1/2 percent mineral oil, the percent of eggs killed being significantly higher than where 1/2 percent mineral oil was used alone or with DDT.

Larvicidal Efficiency Tests

In laboratory experiments an attempt was made to study the effect of prolonged agitation in the spray tank on the efficiency and deposits obtained from spray mixtures of Deenate 25W alone, with oil, and with oil plus soybean flour. Formulas containing 1/4 to 1/2 pound DDT gave too high efficiencies (100 percent in most instances) to demonstrate differences, however, in three separate series of tests the Deenate 25W began to show evidence of preferential wetting by the oil after nine to ten minutes agitation and after 20 minutes most of the DDT had combined with the oil and separated from the diluent which remained in suspension. The mixture, however, was still sprayable after 30 minutes of agitation but the deposit was pellet-like instead of filmed. The average deposit of DDT per square cubic/centimeter of apple surface was 6.2 mmgs. from 2 pounds of Deenate 25W alone, 8.5 from 2 pounds with 1 pint Orthol K oil after one minute of agitation, 10.0 after 3.6 minutes, 9.5 after 10 minutes, 8.5 after 16, and 7.0 after 20. When 4 ounces soybean flour was added no preferential wetting occurred and the deposits ranged from 6.7 to 8.2 mmg. per square cubic centimeter.

In studies of the effect of particle size on efficiency and amount of DDT deposited, no differences could be detected among five lots of aerosol DDT ranging from 1.25 to 5.75 microns in surface mean particle diameter. A 1:1 DDT-kaolin mixture which had been used in 1945 was reground and the surface mean particle diameter reduced to 3.7 microns from its original 6.2. In a comparative test, 1/2 pound to 100 gallons of the finer material showed a larvicidal efficiency of 95.3 and a deposit of 3.2 mmgs. DDT per square cubic centimeter compared with 85.8 percent efficiency and 2.9 mmg. DDT for the original lot. Further tests of 50 percent formulations of DDT and Pyrax or DDT were varied, failed to show any significant differences within the range of 2 to 5.8 microns surface mean particle diameter.

Under laboratory conditions hexaethyl tetraphosphate when used at 1 pint per 100 gallons had a larvicidal efficiency of 76.3 percent one to six hours after spraying and 76.5 percent 20 hours later. The addition of 1 quart mineral oil and 4 ounces Wyoming bentonite to 1 pint of hexaethyl tetraphosphate per 100 gallons gave an initial efficiency of 93.8 percent which declined to 86.2 percent after 20 hours. The oil and bentonite without hexaethyl tetraphosphate showed efficiencies of 26 percent when fresh and 18 percent after 20 hours. The addition of a wetting agent such as 1 ounce dreft or 1 ounce B-1956 per 100 gallons to 8 ounces of hexaethyl tetraphosphate and 1 1/2 pounds of a 50 percent mixture of DDT-Pyrax or Deenate 50W significantly improved both the larvicidal efficiency and the amount of DDT deposited on whole apples sprayed under laboratory conditions.

Laboratory-Field Experiments

The usual method of conducting these experiments was followed (Bureau Circular E-448, September, 1939). Stratified 60-apple samples were taken from each plot shortly before and after the cover sprays and before harvest for larvicide tests. Additional samples were taken at the same time by the chemists for analyses of spray deposits. Ten newly hatched larvae were applied to each apple under controlled laboratory conditions. The larvae came from mixed local strains having a relatively strong ability to enter fruit sprayed with lead arsenate. Approximately 250,000 newly hatched larvae were applied to apples in these tests.

Tests were divided among three series. Series 2 consisted of mature Rome Beauty trees which were also used in a small plot field set-up. Series 3 and 3A consisted of 21 plots arranged on mature Grimes trees. Sprays were thoroughly applied from tower and ground with a conventional sprayer at 600 pounds pressure.

The average larvicidal efficiencies and deposits for the Series 2 tests on Rome Beauty are given in table 1. For details of the spray treatments see table 3 and the list of abbreviations preceding it.

Table 1. Average percent larvicidal efficiencies and results of spray deposit analyses. Rome Beauty. Series 2 plots. Vincennes, Ind. (Deposits given in mmgs. per sq. cm. from Div. Insecticide Inv.)

Plot	Spray treatment (Quantities given for 100 gals.)		May 17-June 21 After sprays	May 17-June 21 Beofre sprays	July 8 - Aug. 29 After sprays	July 8 - Aug. 29 Before spray and harvest
2.	LA-DDT,2-1/4 lb.,Bdx,Oil (2 sprays) 2 qt. Same as 7 in last 2 sprays	Effic.	69.4	35.6	85.6	63.7
		DDT	5.0	2.7	9.6	6.4
22.	LA-DDT,2-1/4 lb.,Fermate 1 lb. Same as 7 in last 2 sprays	Effic.	93.7	42.1	89.6	66.5
		DDT	4.2	1.6	7.3	3.4
7.	NS 1/2 pt.,MB 4 lb., Deenate 1/2 lb.,Oil 2 qt.,SF 2 ozs.	Effic.	Not determined		98.3	89.8
		DDT			9.1	6.0
		Nic.			3.0	1.6
17.	Same as 7 except oil-DDT substituted for Deenate and oil	Effic.	Not determined		97.0	87.1
		DDT			5.8	3.7
		Nic.			2.8	1.5
3.	Deenate 1-1/2 lb.	Effic.	98.8	67.9	99.8	88.1
		DDT	11.9	3.7	12.0	6.0
24.	Same as 3 + oil 1 qt., SF 2 oz., Li. 2 oz.	Effic.	99.0	67.4	99.2	94.8
		DDT	15.3	4.3	19.0	13.0
23.	Niatox 1-1/2 lb.	Effic.	93.1	47.9	96.0	73.3
		DDT	8.6	2.8	7.6	4.3
19.	DDT-P 1-1/2 lb.	Effic.	99.1	59.0	100.0	89.1
		DDT	7.8	2.7	12.2	5.5
20.	DDT-P 1 lb. Oil 1 qt., Wyo. B. 4 oz.	Effic.	Not determined		95.0	84.7
		DDT			17.1	11.3
27.	DDT-BC 1-1/2 lb.	Effic.	95.3	68.4	98.8	90.3
		DDT	9.9	3.2	12.8	6.9
28.	DDT-CL 1-1/2 lb.	Effic.	97.8	69.0	99.5	90.8
		DDT	9.9	3.0	10.6	6.5
48.	No. 28 + 1 qt. Omilite	Effic.	96.0	65.2	99.7	96.5
		DDT	11.1	2.7	13.8	8.0
50.	DDT in solution, atomized	Effic.	78.8	37.6	78.4	44.0
		DDT	6.4	2.8	6.6	4.8
54.	No. 28 in first 4 sprays. Velsicol 1068 1/2 lb. in 1-1/2 pts. xylene + 1/2 oz. B-1956	Effic.	-	-	57.6	32.4

The lead arsenate and DDT used on plots 2 and 22 were ground together in a mikropulverizer without the addition of any diluent. A comparison of these two plots, indicates that the lead arsenate-DDT-bordeaux-oil combination (2) was less effective in the first-brood period than DDT-lead arsenate and Fermate (22) although it deposited larger amounts of DDT. This decreased effectiveness carried over into the second-brood period possibly because of the effect of the bordeaux residues on nicotine bentonite. Results with plots 3 and 24 indicate, as was shown in previous years, that oil, although used at only 1 quart per 100 gallons, greatly increased the resistance of DDT deposits to weathering, increased their build-up and increased larvicidal efficiency. Oil reduces the toxicity of DDT but the increased deposit is generally enough to more than offset this reduction. DDT alone, at 3/4 pound (actual) produced no higher efficiency during the second-brood period than DDT at one-third that strength in combination with one-half strength nicotine bentonite and oil (plot 3 vs. 7). Nicotine bentonite, DDT, and oil (7) when used all season was a more effective treatment during the second-brood period than when used after a first-brood program of lead arsenate and DDT, the difference after periods of weathering being especially pronounced. (We have reported in previous years that lead arsenate residues from early cover sprays adversely affect the toxicity of nicotine deposits from all nicotine bentonite sprays subsequently applied.)

Plot 23 which received a DDT formulation known to be of larger particle size than Deenate was included in order to obtain more information on the effect of particle size on efficiency. The results of tests in previous years indicated that particle size was extremely important in determining the efficiency obtained from DDT formulations. The factory-processed DDT of larger particle size was definitely less efficient than the micronized material represented by Deenate 50W applied to plot 3, and the DDT-Pyrax applied to plot 19.

The results obtained on plot 20 indicate that the addition of a quart of oil per 100 gallons to 1 pound of 50 percent DDT does not quite make up for the reduction of one-third in the actual amount of DDT used as compared with plot 19, however, here again the oil has greatly increased the DDT residue which along with the effect of the oil may be important in the control of certain insects other than the codling moth, particularly the red-banded leaf roller and San Jose scale crawlers.

DDT-Bancroft clay processed in a mikropulverizer gave as good results (27) as Deenate 50W. The same was true of DDT-China L kaolin (28). The latter, in combination with polyethylene polysulfide, gave excellent results during the second-brood period after the wetting agent (goulac) in this adhesive was removed by washing and decantation before use. It aided substantially in maintaining a high efficiency during the long inter-spray intervals following the first-brood period without increasing the DDT residues to the extent that oil did when used with DDT. The atomized solution of DDT, blown onto plot 50 with an orchard duster, gave much less effective results than the conventional

type of spray and produced some spot-type injury. Velsicol 1068 in xylene, emulsified with Triton B-1956 does not appear promising as a codling moth insecticide, since part of the efficiency shown for this plot must be attributed to first-brood residues of DDT.

In the experiments on the Grimes Golden variety, six cover sprays were applied on May 9, 23, June 10, 25, July 16 and August 1. These were preceded by a calyx and two lead arsenate cover sprays applied by the grower within 14 days after petal fall and before the block was divided into experimental plots.

Except where DDT was combined with nicotine bentonite in which case the amount used was 4 ounces, the standard dilution used in the experimental treatments was 1/2 pound actual DDT per 100 gallons. Most of the DDT formulations tested in these series produced average efficiencies for fresh deposits of between 99 and 100 percent, consequently most differences between treatments appeared only at the end of weathering periods. A 50 percent formulation of DDT-Pyrax (micronized) was used as the standard of comparison. It was equalled in effectiveness during the first-brood period and exceeded during the second-brood after periods ofweathering by DDT dissolved in xylene, either with Wyoming bentonite or Triton B-1956, as emulsifying agents. Xylene could be used at either 1-1/2 pints per 1/2 pound of DDT or at 1 pint without influencing efficiency. When DDT was dissolved in Velsicol AR 50 Special, the efficiency during the first-brood period was significantly less after periods of weathering than obtained with DDT-Pyrax. This was not true during the latter part of the season when the DDT-Velsicol emulsion exceeded the DDT-Pyrax in effectiveness and also exceeded it in amount of DDT deposit. An aerosol DDT reprecipitated so as to have a mean surface particle diameter of approximately 2.25 microns, and used with 1/2 ounce B-1956 as wetting agent proved less effective than a DDT-Pyrax mixture also wet with B-1956 and was also slightly less effective than a similar preparation having a mean surface particle diameter of 5 microns. The 5-micron material, however, was made up of long needle-like crystals while the 2.25-micron material was of short needle-like crystals and had a tendency to agglomerate. During the second half of the season a 5-micron material was made from the aerosol DDT by grinding and was used with B-1956 in a similar manner. It proved slightly more effective after periods of weathering than either of the needle-like preparations and was slightly more effective than DDT-Pyrax which had a mean surface particle diameter of 4 microns. On the basis of tests conducted to date the optimum surface mean particle diameter for DDT particles used in codling moth formulations appears to lie between 3 and 5 microns.

A 5:3:2 formulation of DDT-Silene (calcium silicate)-Wyoming bentonite having a surface mean particle diameter of 1.50 microns proved significantly more efficient and more resistant to weathering than DDT-Pyrax. The addition of oil to this formulation decreased the efficiency somewhat although it increased the deposits. At 1/2 pound actual DDT per 100 gallons DDT-Pyrax was more efficient when freshly applied than one pint of nicotine sulfate in a nicotine bentonite-oil mixture, however, after 11 to 22 days of weathering the nicotine bentonite formula was significantly more effective than the DDT. Half-strength nicotine bentonite with 1/2 percent oil in combination with 4 ounces actual DDT was more effective after the first-brood sprays than the full strength nicotine bentonite and equally effective after periods of weathering. During the second-brood period these formulas were equally effective after the sprays but the nicotine bentonite-DDT combinations were slightly less efficient after 14 to 22 days of weathering. When DDT impregnated in Mississippi bentonite was used in combination with nicotine bentonite the efficiencies of fresh as well as weathered deposits in the first-brood period were significantly less than where the DDT was added to nicotine bentonite in the form of Deenate 50. In the second-brood period there was no significant difference between these formulas. When DDT was dissolved in Velsicol and added to the nicotine-bentonite-oil formula the efficiency of fresh deposits in the first-brood period was less than the Deenate-nicotine bentonite combination but there was no difference in the efficiency of the weathered residues. There was also no difference between the efficiency of either weathered or fresh residues during the second-brood period. When the DDT was added to nicotine bentonite in the form of DDT-Pyrax (micronized) there was no difference in efficiency from that obtained with nicotine bentonite and Deenate. Black leaf 155X, containing 12 percent nicotine and 7 percent DDT, used at 2 pounds per 100 gallons with 2 quarts of oil was significantly less efficient than half-strength tank-mix nicotine bentonite with Deenate and oil. The difference in the efficiency of weathered deposits during the first-brood period averaged 20 percent. Black leaf 155Y, containing the same quantities of DDT and nicotine but with all the nicotine in a water soluble form, was more efficient than the Black Leaf 155X formula during the first-brood period when sprays were applied at shorter intervals but was significantly less efficient during the second-brood period. A 25 percent DDT experimental formulation with ground tobacco as a diluent was equal in efficiency to DDT-Pyrax (micronized). When Black Leaf 155Y was used with 2 quarts of oil per 100 gallons in second-brood sprays on part of the 25 percent DDT plot the efficiency was less during this period both with respect to fresh and weathered deposits than where the DDT-155Y formula had been used all season.

The addition of 1/2 ounce per 100 gallons of the emulsifier Triton B-1956 to DDT-Pyrax in three sprays increased the amount of DDT deposits slightly and the efficiency significantly. When the amount of emulsifier was increased to one ounce in the fourth and fifth cover sprays the increase in amount of spray material remaining on the tree at time of application was reduced slightly but the rate of weathering

was not increased with the result that the average efficiency remained about the same as where no emulsifier was used. When the emulsifier was increased to 1 1/2 ounces in the last application the amount of DDT deposited was significantly reduced. Again, however, there was no increase in the rate of weathering as a result of using the emulsifier and the average efficiency was approximately the same. The factory-processed formulation, Tobacine, which contained 15 percent DDT and was used at the rate of 20 ounces per 100 gallons gave no better results than was to be expected from the use of 3 ounces of DDT alone. Di (methoxyphenyl) trichloroethane used at the rate of 1/2 pound of the active ingredient per 100 gallons proved much less effective than the DDT-Pyrax mixture, following the first three cover sprays. After the fourth and fifth cover sprays, however, it averaged only slightly less effective than the DDT-Pyrax mixture. Following the last spray it lost efficiency much more rapidly than the DDT-Pyrax mixture, due perhaps to the heavy rainfall.

Two formulations of benzene hexachloride were tested in four first-brood sprays. One (commercial solvent preparation) was made up in dust form and contained five percent of the gamma isomer, the other was obtained in technical form from the Hooker Electro Chemical Co. and was said to contain 20 percent of the gamma isomer. This was ground with an equal quantity of kaolin and used at the rate of 5 pounds per 100 gallons. The dust was used at the rate of 10 pounds both formulations being used as sprays. The larvicidal efficiency was extremely low throughout the first-brood period, the maximum being 53 percent after four sprays of the benzene hexachloride-kaolin mixture had been applied. The average efficiency after sprays was 23.8 percent in one case and 34.5 in the other. The average efficiency after weathering was 16.6 and 14.4. Benzene hexachloride, as represented by the test formulations, does not show promise as a codling moth larvicide.

The Effect of DDT Spray Residues in Reducing Oviposition

Reduced catches in bait traps following application of DDT sprays over a period of three years have indicated that DDT sprays not only have an effect on moths wet at the time of applications, but that the resulting deposits on which moths must subsequently lay their eggs are toxic to them. Results of tests conducted in 1946 in which moths were caged on trees sprayed with DDT for periods of five days following three different applications are given in Table 2.

Table 2. Effect of DDT Deposits on Foliage on Codling Moth Oviposition, Vincennes, Indiana - 1946

Treatment (Materials and Amounts per 100 Gallons)	Experiments Conducted	Moths Dead after 5 Days 1/	Reduction in Eggs Deposited 1/
	Number	Percent	Percent
DDT-xylene emulsion (8 oz. DDT)	3	100	93
DDT-Aerosol (8 oz.)(2.5 micron)	3	100	90
DDT-Pyrax (50%)(8 oz. DDT)	3	100	81
DDT-Velsicol emulsion (8 oz. DDT)	2	100	78
Di (methoxyphenyl) trichloroethane (8 oz.)	3	90	81
Nicotine bentonite oil, DDT (4 oz.)	3	94	76
Benzene Hexachloride (8 oz. Gamma Isomer)	2	90	76
TM Nicotine bentonite oil	1	85	33
Unsprayed	3	78	0

1/ Averages of tests made after the 3rd, 4th and 5th cover sprays.

The average number of eggs per female laid on unsprayed foliage during the five-day periods was 37. Since the codling moth is at rest on the trees except during the short periods of flight, the confinement of moths in cages probably did not give an exaggerated effect, particularly since some of the moths in the cages in the unsprayed plots were killed by ants.

Field Testing of Insecticides on Randomized Plots

Small plot tests were arranged in a mixed planting of mature Winesap and Jonathan trees (Series 1), on mature Rome Beauty and Turley (Series 2), and on Rome Beauty replants (Series 2A) too small for inclusion in the regular Rome Beauty plots but located among or near them. Codling moth data, representative of the entire crop, were obtained on all varieties at the end of first-brood attack and later for the entire season. Red-banded leaf roller injury data were obtained from all drops and harvested fruit. To determine the mite population

examinations of an average of 100 leaves per variety per plot were made from six to eight times during the season, using the brush type machine developed by C. F. Henderson as an aid in making the counts. In series 1, one Jonathan tree in each of two replicates and one or two Winesap trees in each of the four replicates were examined. Yields in the Winesap and Jonathan plots ranged from 2,749 to 4,743 apples per tree, in Rome Beauty plots (Series 2) from 2,311 to 4,077 and in Turley plots (Series 2) from 3,471 to 4,808. On Rome Beauty replants the yield in plot 50 was only 179 apples per tree but in the other plots it ranged from approximately 1,400 to 4,000.

Series 1 was set up primarily to test promising codling moth programs against the European red mite and the two-spotted mite. For this reason the individual replicates included 4 trees to minimize the effect of wind-drift of mites from one replicate to the other. The other series was made up of single-tree plots replicated three to seven times. At the end of first-brood attack, examinations of stratified samples on the trees failed to show much red-banded leaf roller injury; however, since the foliage was becoming somewhat ragged, records of damage by this pest were kept on all drops picked up after July first.

The abbreviations used to indicate materials referred to in the tables in this report are listed below along with the surface mean particle diameter (SMPD) of preparations containing DDT. Unless otherwise indicated, the technical grade of DDT was used in all DDT formulations.

155-DDTX (Blackleaf 155, 12% Nic. + 7% DDT with bentonite) SMPD-7.5m.

Azo. C (Azobenzene-China L kaolin (50%) mikro.)

Azo. S (Azobenzene-Silene (50%) mikro.)

B-1956 (Triton B-1956)

Bdx. (3/4:1-1/2:100 Bordeaux mixture)

BS (bentonite sulfur, fused)

"Deenate" (Deenate 50W, DuPont) SMPD-2.8

"Deenate 25" (Deenate 25W, 1945)

DDT-A (DDT aerosol-Bancroft clay (50%) mikro.) SMPD-2.0

DDT-BC (DDT-Bancroft clay (50%) mikro.) SMPD-2.6

DDT-CL (DDT-China L kaolin (50%) mikro.) SMPD-2.6

Abbreviations (Continued)

DDT-P (DDT-Pyrax (50%) micronized) SMPD-4.0

DDT-SW (DDT-Silene-Wyo. B. (5:3:2) mikro.) SMPD-1.5

DDT-Xan. (DDT-zanthone (37-1/2% and 50%) General Chem. Co.) SMPD-8.0

DiMT (di (methoxyphenyl) trichloroethane, 50%)

DN-111 (derivative of dinitro ortho cyclohexyl phenol)

"Fermate" (ferric dimethyl dithiocarbamate)

HPF (hydroxy pentamethyl flavan, 30%)

LA (standard acid lead arsenate)

LA-DDT (LA-DDT (8:1) mikro.) SMPD-0.6

Li (hydrated spray lime)

MB (Miss. bentonite, Filtrol X415 brand)

Mikro. (processed laboratory's Bantam Mikropulverizer)

"Niatox" (DDT 50%. Niagara Sprayer & Chem. Co.) SMPD-7.6

NS (nicotine sulfate, 40%)

Oil (Superla, emulsive type summer spray oil)

Oil-DDT (4% DDT in Superla Std. Oil Co.)

"Omilite" (polyethylene polysulfide, 50%)

"Rose Special" (1% rotenone emulsion, Liberty Chemical Co.)

SF (soybean flour, "Spraysoy," Glidden Co.)

"Tobacine" (15% DDT with tobacco extracts)

WS (wettable sulfur)

Wyo. B. (Wyoming bentonite. Am. Colloid Co.)

Spray formulas used on the three series of plots are given in Table 3.

Table 3. Spray Formulas used in Small Plot Field Tests in 1946.
Vincennes, Indiana

A 3% dormant oil spray was applied from opposite directions about March 11 and 14 by the grower.

Prebloom sulfur sprays and dusts were also applied by the grower. Seven cover sprays were applied on April 29-May 4, May 13-14, 28-29, June 11-12, July 3-5, 22-23, and August 15-19.

Series 1. Winesap and Jonathan (17 treatments, four 2x2-tree replicates of each)

Plot	Spray No.	Quantities of materials used per 100 gallons.
All	Calyx	LA 3 lb., WS 3 lb., Li. 3 lb. (April 8-10)
1,2	10-day	LA 4 lb., WS 4 lb., Li. 4 lb. (April 19-20)
3-17	10-day	WS 4 lb. (April 19-20)
1	1	LA 4 lb., Li. 4 lb., BS 3 lb.
	2	LA 4 lb., Li. 4 lb., oil 1 qt., SF 4 oz.
	3-4	LA 4 lb., Bdx. Oil 2 qt.
	5-7	LA 3 lb., Bdx.
2	1	LA 2 lb., Deenate 25 1 lb., Li. 2 lb. BS 3 lb.
	2	LA 2 lb., Deenate 1/2 lb., Li. 2 lb., Oil 1 qt., SF 2 oz.
	3-4	LA 2 lb., Deenate 1/2 lb., Bdx., Oil 2 qt.
	5-7	Same as Plot 7. (NS 1/2 pt., MB 4 lb., Oil 2 qt., Deenate 1/2 lb., SF 2 oz.)
3	1	Deenate 25, 3 lb., BS 3 lb.
	2,4-7	Deenate 1-1/2 lb.
	3	Deenate 1-1/2 lb., Bdx.
4	1-4	Same as Plot 3
	5-7	Deenate 3/4 lb., SF 2 oz., Li. 2 oz., Oil 1 gal.
5	1	NS 1 pt., MB 8 lb., BS 3 lb.
	2	NS 1 pt., MB 8 lb., Oil 1 qt.
	3-7	NS 1 pt., MB 8 lb., Oil 2 qt.
6	1	NS 1/2 pt., MB 4 lb., Deenate 25, 1-1/2 lb., BS 3 lb.
	2	NS 1/2 pt., MB 4 lb., Deenate 3/4 lb., Oil 1 qt., SF 2 oz.
	3-7	NS 1/2 pt., MB 4 lb., Deenate 3/4 lb., Oil 2 qt., SF 2 oz.
7	1	NS 1/2 pt., MB 4 lb., Deenate 25, 1 lb., BS 3 lb.
	2	NS 1/2 pt., MB 4 lb., Deenate 1/2 lb., Oil 1 qt., SF 2 oz.
	3-7	NS 1/2 pt., MB 4 lb., Deenate 1/2 lb., Oil 2 qt., SF 2 oz.
8	1	Deenate 25, 3 lb., BS 3 lb.
	2,4-6	Deenate 1 lb., SF 2 oz., Li. 2 oz., Oil 1 qt.
	3	Deenate 1 lb., Bdx., Oil 1 qt.
	7	Deenate 1 lb., SF 2 oz., Li. 2 oz., Oil 2 qt.

Table 3 (Continued) Series 1 (Continued)

Plot	Spray No.	Quantities of materials used per 100 gallons
9	1	Deenate 25, 3 lb., BS 3 lb.
	2-7	Same as Plot 8 except Deenate reduced to 1/2 lb.
10	1	DiMT 1-1/2 lb., BS 3 lb.
	2,4-7	DiMT 1-1/2 lb.
	3	DiMT 1-1/2 lb., Bdx.
11	1-4	Same as Plot 3
	5-7	DDT-Xan. 2 lb.
12	1-4	Same as Plot 3
	5-7	Deenate 1-1/2 lb., HPF 4 lb.
13	1-4	Same as Plot 3
	5-7	Deenate 1 lb., HPF 2 lb., Oil 1 qt.
14	1-2	Same as Plot 3
	3	Deenate 1-1/2 lb., HPF 1 lb., Bdx.
	4-7	Deenate 1-1/2 lb., HPF 1 lb.
15	1-4	Same as Plot 3
	5-7	Same as Plot 7
16	1-4	Same as Plot 3
	5-7	Deenate 1-1/2 lb., DN-111, 1-1/4 lb.
17	1-2	Same as Plot 3
	3-7	Deenate 1-1/2 lb., DN-111 5 oz.

Series 2. Rome Beauty (16 treatments, single-tree plots replicated 7 times).

Plot	Spray No.	Quantities of materials used per 100 gallons.
All	Calyx	LA 3 lb., WS 3 lb., Li. 3 lb. (April 10-13)
1,2	10-day	LA 4 lb., WS 4 lb., Li. 4 lb. (April 22)
22	10-day	LA 4 lb., Fermate 1 lb. (April 22)
All others	10-day	WS 4 lb. (April 22-23)

Six cover sprays were applied on May 6-7, 20-21, June 3-5, 18-20, July 9-11, and August 8-9.

Table 3. (Continued) Series 2 (Continued)

Plot	Spray No.	Quantities of materials used per 100 gallons.
1	1-2	LA 4 lb., Li. 4 lb., BS 3 lb.
	3-4	LA 4 lb., Bdx., Oil 2 qt.
	5-6	LA 3 lb., Bdx.
2	1-2	LA-DDT 2-1/4 lb., Li. 2 lb., BS 3 lb.
	3-4	LA-DDT 2-1/4 lb., Bdx., Oil 2 qt.
	5-6	Same as Plot 7. (NS 1/2 pt., MB 4 lb., Deenate 1/2 lb., Oil 2 qt., SF 2 oz.)
22	1	LA-DDT 2-1/4 lb., Fermate 1 lb., BS 3 lb.
	2-4	LA-DDT 2-1/4 lb., Fermate 1 lb.
	5-6	Same as Plot 7. (NS 1/2 pt., MB 4 lb., Deenate 1/2 lb., Oil 2 qt., SF 2 oz.)
3	1-2	Deenate 1-1/2 lb., BS 3 lb.
	3-5	Deenate 1-1/2 lb.
	6	Deenate 1-1/2 lb., DN-111, 3/4 lb.
24	1-2	Same as Plot 3
	3-5	Deenate 1-1/2 lb., SF 2 oz., Li. 2 oz., Oil 1 qt.
	6	Deenate 1-1/2 lb., SF 2 oz., Li. 2 oz., Oil 2 qt.
25	1-4	Same as Plot 24
	5	Deenate 1-1/2 lb., HPF 2 lb., Oil 1 qt.
	6	Deenate 1-1/2 lb., WS 2 lb.
5	1-2	NS 1 pt., MB 8 lb., BS 3 lb.
	3-6	NS 1 pt., MB 8 lb., Oil 2 qt.
7	1-2	NS 1/2 pt., MB 4 lb., Deenate 1/2 lb., BS 3 lb.
	3-6	NS 1/2 pt., MB 4 lb., Deenate 1/2 lb., Oil 2 qt., SF 2 oz.
17	1-2	Same as Plot 7
	3-6	NS 1/2 pt., MB 4 lb., Oil-DDT 2 qt.
18	1-2	155-DDTX 2 lb., BS 3 lb.
	3-6	155-DDTX 2 lb., Oil 2 qt., SF 2 oz.
19	1-2	DDT-P 1-1/2 lb., BS 3 lb.
	3-5	DDT-P 1-1/2 lb.
	6	DDT-P 1-1/2 lb., DN-111, 3/4 lb.
20	1-2	Same as Plot 19
	3-5	DDT-P 1 lb., Wyo. B. 4 oz., Oil 1 qt.
	6	DDT-P 1 lb., Wyo. B. 4 oz., Oil 2 qt.
21	1-2	Same as Plot 19
	3-5	DDT-P 1/2 lb., Wyo. B. 4 oz., Oil 1 qt.
	6	DDT-P 1/2 lb., Wyo. B. 4 oz., Oil 2 qt.

Table 3 (Continued) Series 2 (Continued)

Plot	Spray No.	Quantities of materials used per 100 gallons.
26	1-5	DDT (tech.) 3/4 lb. in Xylene 2-1/4 pt. plus B-1956 1/2 oz.
	6	DDT (tech.) 3/4 lb. in Xylene 2-1/4 pt. and Oil 2 qt. plus B-1956 1/2 oz.
23	1-2	Niatox 1-1/2 lb., BS 3 lb.
	3-6	Niatox 1-1/2 lb.
27	1-2	DDT-BC 1-1/2 lb., BS 3 lb.
	3-5	DDT-BC 1-1/2 lb.
	6	DDT-BC 1-1/2 lb., DN-111, 3/4 lb.

Series 2. Turley (8 treatments, single tree plots replicated 4 times).

1	1-6	Same as Rome Beauty Plot 1
3	1-6	Same as Rome Beauty Plot 3
5	1-6	Same as Rome Beauty Plot 5
7	1-6	Same as Rome Beauty Plot 7
19	1-6	Same as Rome Beauty Plot 19
27	1-6	Same as Rome Beauty Plot 27
28	1-2	DDT-CL 1-1/2 lb., BS 3 lb.
	3-5	DDT-CL 1-1/2 lb.
	6	DDT-CL 1-1/2 lb., DN-111, 3/4 lb.
29	1-2	DDT-A 1-1/2 lb., BS 3 lb.
	3-5	DDT-A 1-1/2 lb.
	6	DDT-A 1-1/2 lb., DN-111, 3/4 lb.

Table 3. (Continued)

Series 2A. Rome Beauty Replants, 3 single trees paired with 3 sprayed with formula 28.

Plot	Spray No.	Quantities of materials used per 100 gallons.
28	1-2	DDT-CL 1-1/2 lb., BS 3 lb.
	3-5	DDT-CL 1-1/2 lb.
	6	DDT-CL 1-1/2 lb., DN-111, 3/4 lb.
47	1-2	DDT-SW 1-1/2 lb., BS 3 lb.
	3-5	DDT-SW 1-1/2 lb.
	6	DDT-SW 1-1/2 lb., DN-111, 3/4 lb.
48	1-2	DDT--CL 1-1/2 lb., BS 3 lb., Omilite 1 qt.
	3-6	DDT-CL 1-1/2 lb., Omilite 1 qt.
49	1-3	Same as Plot 28
	4	DDT-CL 1-1/2 lb., Azo C 3/4 lb.
	5	DDT-CL 1-1/2 lb., Azo C 1-1/2 lb.
	6	DDT-CL 1-1/2 lb., Azo C 3 lb.
50	1-6	Atomized solution DDT blown into trees. DDT (tech.) 1 lb. per gal. xylene-kerosene (1:3)
51	1-5	Tobacine 1 pt.
	6	Discontinued (not applied)
52	1-3	Same as Plot 28
	4	DDT-CL 1-1/2 lb., Azo S 3/4 lb.
	5	DDT-CL 1-1/2 lb., Azo S 1-1/2 lb.
	6	DDT-CL 1-1/2 lb., Azo S 3 lb.
53	1-3	Same as Plot 28
	4-6	DDT-CL 1-1/2 lb., Rose Special 1 qt.
54	1-4	Same as Plot 28
	5-6	Velsicol 1068, 1/2 lb. in 1-1/2 pt. xylene + 1/2 oz. B-1956

Codling moth, red-banded leaf roller, and mite infestation data are summarized in tables 4, 5, and 6.

Table 4. Codling Moth, Red-Banded Leaf Roller and Mite Infestations on Winesap and Jonathan. Series 1 Tests. Vincennes, Ind., 1946.

(DDT in Form of "Deenate" Used)	Codling Moth: Harvest Data: Clean Apples	Codling Moth: Harvest Data: Worms per 100 Apples	Codling Moth: 1st Brood Worms per Tree June 28	RBLR: Injured Apples	Number Mite Adults and Nymphs Per 100 Leaves: Average on 5 Dates after July 2 1/: ERM 2/	Number Mite Adults and Nymphs Per 100 Leaves: Average on 5 Dates after July 2 1/: 2-SM 3/	Number Mite Adults and Nymphs Per 100 Leaves: Maximum Population (both species)
	Percent	Number	Number	Percent			
1. (LA)	57.1	67.3	137	0.2	158	770	2495
2. (DDT-LA: NB-DDT)	84.0	15.8	66	1.4	24	718	1233
3. (DDT)	96.0	2.4	7	8.9	696	2359	4658
4. (DDT-oil)	94.0	4.8	--	16.0	28	1043	2625
5. (NB)	89.9	8.0	44	12.7	71	365	1212
6. (NB-DDT)	96.5	2.8	19	7.4	46	1369	2865
7. (NB-DDT)	93.0	5.6	58	12.8	26	1258	3075
8. (DDT-oil)	94.2	3.2	13	6.8	74	2215	5720
9. (DDT-oil)	91.4	6.6	34	15.2	110	2082	4730
10. (DiMT)	82.4	20.2	88	15.1	393	3113	4900
11. (DDT-Xan)	90.6	8.9	--	13.6	392	1911	4960
12. (DDT-HPF)	95.4	2.4	--	14.2	318	1652	2912
13. (DDT-HPF-oil)	95.7	2.6	--	12.2	95	1905	3175
14. (DDT-HPF)	94.7	4.0	29	9.4	570	2513	4816
15. (DDT:DDT-NB)	95.0	3.4	19	17.6	41	1345	3575
16. (DDT-DN-111)	95.4	2.6	27	14.0	210	127	788
17. (DDT-DN-111)	95.6	2.3	32	10.7	564	498	2610

1/ These are averages of populations found on July 19, 27, Aug. 12, 26 and September 17.
2/ European red mite, Paratetranychus pilosus (C & F).
3/ Two-spotted spider mite, Tetranychus bimaculatus (Harvey).

Table 5. Codling Moth, Red-Banded Leaf Roller and Mite Infestations on Rome Beauty. Series 2 Tests. Vincennes, Indiana - 1944.

Plot	Codling Moth Clean Apples	Codling Moth Worms per Tree (Season)	RBLR Injured Apples	Average Number Mite Adults and Nymphs per 100 Leaves Before 1/ and After 2/ Final Spray: ERM Before	ERM After	2-SM Before	2-SM After
	Percent	Number	Percent	Before	After	Before	After
1. (LA)	95.0	125	0.4	456	131	2342	2272
2. (LA-DDT-Oil: NB-DDT-Oil)	98.6	16	1.8	142	19	1868	444
22. (LA-DDT-Fermate: NB-DDT-Oil	97.9	21	1.2	226	2	3578	833
3.3/ (Deenate)	96.8	17	16.4	388	35	4162	60
24. (DDT + Oil)	97.6	6	11.2	185	51	2914	832
25. (DDT + Oil)	98.4	8	6.1	175	169	3377	2418
19. (DDT-P)	97.7	18	15.1	664	76	4214	281
20. (DDT-P + Oil)	97.6	11	15.5	166	14	3574	509
21. (DDT-P + Oil)	96.7	21	29.0	222	7	3352	890
23. (Niatox)	95.7	30	23.3	577	38	2900	992
27. (DDT-BC)	96.7	29	22.1	757	46	3562	74
26. (DDT-Xylene)	97.8	16	6.7	648	122	2707	2051
5. (NB-Oil)	96.8	45	28.5	138	23	2120	488
7. (NB-DDT-Oil)	97.0	31	26.7	123	92	2199	1348
17. (NB-DDT in Oil)	96.8	24	34.6	114	29	2060	1454
18. (155-DDTX-Oil)	95.6	47	43.2	116	58	2264	1105

1/ Average of populations on July 17 and August 5.

2/ Average of populations on August 16 and September 16.

3/ DN-111 at 3/4 pound per 100 gallons used on underscored plots in final application.

Table 6. Codling Moth, Red-Banded Leaf Roller and Mite Infestations on Turley, Series 2, and Rome Beauty, Series 2A. Vincennes, Ind., 1946.

Plot	Clean Apples	Worms per Tree (Season)	RBLR In-jured Apples	Average Number Mite Adults and Nymphs per 100 Leaves Before 1/ and After 2/ Final Spray			
				ERM		2-SM	
	Percent	Number	Percent	Before	After	Before	After
Turley							
1. LA	95.8	105	0.3	518	98	2485	214
3.3/ Deenate	98.1	22	11.6	1200	28	2046	116
5. NB	98.4	28	14.0	102	30	1364	647
7. NB-DDT	98.0	22	14.4	1715	72	2500	945
19. DDT-P	98.6	18	14.3	1146	10	5265	120
27. DDT-BC	98.1	18	15.0	834	12	3491	68
28. DDT-CL	98.1	22	13.6	1074	9	2930	82
29. DDT-A	98.2	18	11.7	729	48	3291	355
Rome Beauty Replants (Compare with 28 in same group)							
28. S.W.	96.4	28	14.7	400	22	2432	136
47. DDT-SW	97.7	6	6.6	600	24	6043	20
28. -S	95.3	26	28.6	710	18	1784	172
48. No. 28-Omilite	97.6	12	25.7	628	64	6343	592
28. SE	94.0	72	43.4	710	18	1784	172
49. No. 28—Azo. C.	95.6	64	32.7	352	83	1856	497
52. No. 28--Azo. S.	94.9	53	38.4	470	47	1810	192
53. No. 28--Rome Special	95.0	51	33.1	252	154	1732	1019
54. V. 1068	90.9	275	51.9	391	137	664	143
Unsprayed (Light crop)	53.5	371	54.8	314	48	789	59
28.- NE	95.8	8	15.3	1188	127	5766	298
50.- Solution atomized (very light crop)	93.8	13	24.5	1210	188	7766	360
28.- W	97.2	8	9.7	400	22	2432	136
51.- Tobacine	90.6	63	36.7	607	40	2703	1006

1/ Average of populations on July 17 and August 5.
2/ Average of populations on August 16 and September 5.
3/ DN-111 at 3/4 pound per 100 gallons used on underscored plots in final application.

Winesap and Jonathan, Series 1

Among the treatments in this series the standard lead arsenate one was the poorest and di(methoxyphenyl) trichloroethane was the second poorest with respect to codling moth control. Plots 2 and 7, receiving only 4 ounces of DDT in combination with either lead arsenate or nicotine bentonite, rated next poorest at the end of first-brood attack. At the end of the period of first-brood attack plots 3, 4, 11, 12, 13, 15, and 16, which were sprayed alike with 3/4 pound actual DDT per 100 gallons in the four first-brood sprays, had from 7 to 27 worms per tree. Different miticides were used on these plots during the second-brood period. DN-111 and hydroxy pentamethyl flavan did not significantly reduce the effectiveness of DDT against the codling moth as indicated by the final results. Nicotine bentonite-DDT and oil in the second-brood period (Plot 2) was definitely less effective against codling moth than nicotine bentonite-DDT all season (Plot 7). However, plot 2 had two of its replications immediately adjacent to the most heavily infested replications of plot 1 and was at a definite disadvantage in this respect. On other varieties the two treatments have appeared about equally effective. Plot 6, which received 2 ounces more DDT per 100 gallons, had significantly less codling moth injury than plot 7. The results on plot 8, compared to 3, indicate that DDT can be reduced one-third without any loss in effectiveness if one quart of oil is added. On plot 9, in which DDT was used at only 4 ounces per 100 gallons in all sprays, control of codling moth was equal or better than that obtained with the full strength nicotine bentonite program (Plot 5). In plot 11, which received DDT-xanthone in the last three sprays with the DDT being used at 3/4 pound actual in all seven cover sprays, the program was no more effective than the full strength nicotine bentonite program.

The two plots which received lead arsenate in the first-brood period, either at 4 pounds per 100 gallons (Plot 1) or at 2 pounds per 100 gallons, (Plot 2) supplemented with 4 ounces DDT, suffered very little leafroller injury to the fruit and foliage. The infestation on the DDT sprayed plots, however, ranged up to 17.6 percent. In general the DDT plots on which the heaviest DDT residues were deposited had the least red-banded leaf roller damage to fruit.

The red-banded leaf roller has undoubtedly been present in the Middle West for many years, where it appears to go through three or more generations per year. In 1946 it continued feeding on foliage until in November. Since it feeds on many kinds of plants and is not controlled by nicotine bentonite, yet never caused commercial damage during the eight-year period just passed in which nicotine bentonite was used almost exclusively by some of our growers, we attribute the current outbreak to destruction of parasites or predators by DDT sprays. Weather conditions may have been a contributing factor.

During the past season the 265-acre orchard at Vincennes in which most of our small field plot tests were conducted was sprayed eight times with DDT (after a petal fall spray of lead arsenate) by the grower. A straight DDT program was used in part of the orchard both in 1944 and 1945. The leaf roller in each of those seasons did not affect one percent of the fruit but in 1946 this entire orchard became heavily infested. A heavy second-brood attack began in July in the grower-sprayed part of the orchard as well as in the experimental plots. By mid-August up to 12 egg masses per 100 leaves averaging 40 eggs per mass could be found in Duchess and Transparent trees sprayed prior to July with DDT. On September 20, 475 leaf roller adults were knocked down from two 15-year old trees when they were fumigated with nicotine vapor.

With respect to the European red mite infestation, the plots which received oil supported the smallest populations. In this orchard a thorough application of 3 percent dormant oil was applied with the wind from opposite directions in March which accounts for the rather low level of infestation by the European red mite. Plot 3, the only plot receiving DDT without a miticide, carried the heaviest European red mite infestation. Di (methoxyphenyl) trichloroethane, DDT-xanthone, DDT and hydroxy pentamethyl flavan at 4 pounds of the 30 percent mixture in three sprays and at 1 pound in five sprays (Plot 14), and DDT with DN-111 at 5 ounces in five sprays all failed to show any substantial control of the European red mite. DDT with 1-1/4 pounds DN-111 in the last three sprays gave only fair control of the European red mite but gave outstanding control of the two-spotted mite. DN-111 at only 5 ounces in five sprays, as a supplement to DDT (Plot 17) gave substantially better control of the two-spotted mite than oil (plots 2, 4, 5, 6 and 7,) although no noticeable damage from mites developed in the plots receiving oil.

Rome Beauty, Series 2

The codling moth infestation in the Series 2, plot 1 was extremely light. Here again lead arsenate was definitely less effective than the other combinations tested and a factory-processed DDT-nicotine bentonite combination and full strength tank-mix nicotine bentonite, plots 18 and 5 respectively, were next least effective. Best results were obtained on plots 24 and 25 with 3/4 pound DDT supplemented with oil in three or four of the cover sprays.

The red-banded leaf roller infestation in this series of plots again demonstrates the necessity for inclusion of lead arsenate in the first-brood spray program. Treatments 1, 2, and 22 in which from 2 to 4 pounds lead arsenate was used in all first-brood sprays gave satisfactory control. In general, of the treatments that included no lead arsenate, those that included the least amount of DDT (18, 17, 7 and 21) gave the poorest control of the leaf roller. DDT in xylene, emulsified with Triton B-1956 (Plot 26), and full strength DDT with oil (Plots 24 and 25), gave the best control of the red-banded leaf roller among the plots which received DDT but no lead arsenate.

From the standpoint of foliage condition, Fermate, as used in plot 22, was superior to bordeaux, as used in plots 1 and 2, as a safener for lead arsenate-DDT in the first-brood period.

Because of the danger from a rapidly increasing two-spotted spider mite infestation early in August, DN-111 was added to all except one of the straight DDT plots in the final spray and oil, where used, was increased from 1/4 to 1/2 percent. However, during or immediately following the application of this spray, a period of very heavy rains occurred and it was not possible to determine how much the rains or the natural decline in population accounted for the reductions that followed the application of the last spray. Plot 23 was left as a straight DDT program without a miticide and its mite infestations declined below that of some of the plots which received oil. It is perhaps significant, however, that plot 25, which received 2 pounds of sulfur in the last spray had the heaviest two-spotted spider mite infestation on the two dates samples were taken after this application. A lead arsenate plot on which no miticide was applied also maintained a high population late in the season. The plots which received DN-111 (3,19, and 27) had the lowest two-spotted mite population.

Turley and Rome Beauty Replants, Series 2 and 2A

On the Turley variety (Table 6) lead arsenate again gave poor results against the codling moth compared to the other treatments, which were about equally effective. Here again the red-banded leaf roller caused little or no injury in the lead arsenate plots and injured from 11.6 to 15 percent of the fruit in the plots which were sprayed with DDT or nicotine bentonite. On this variety the European red mite infestation before the final spray was highest on the plot which received nicotine bentonite and DDT with 2 quarts of oil; however, since there were only four replicates the differences among these treatments have less significance than those on the Rome Beauty, Winesap and Jonathan.

Results on the Rome Beauty replants indicate that DDT in combination with Silene and bentonite (Plot 47) is a more effective combination than DDT and China L kaolin (Plot 28). The addition of polyethylene polysulfide to DDT-China clay seemed to increase codling moth control slightly. The addition of azo benzene or rotenone emulsion to the DDT-China L clay combination had no significant effect on codling moth control. Substitution of Velsicol 1068 for DDT in the two final sprays resulted in a substantial loss in effectiveness against codling moth, the number of worms per tree increasing to 275 compared to 72 for a full DDT program. Tobacine as compared to DDT-China L kaolin was very ineffective against codling moth. Most of these replants were in a section of the orchard where the red-banded leaf roller infestation was the heaviest. To the east of them, Rome Beauty fruit in the part sprayed by the grower averaged 63 percent leaf roller injury. It is interesting to note that the unsprayed trees in series 2A were the most heavily infested of the

replants while adjacent trees sprayed with DDT-China L kaolin ranged from 33.7 to 43.4. For the control of mites azo benzene showed only a slight degree of effectiveness. Inasmuch as DN-111 was used on all of the No. 28 plots in the final spray the data in Table 6 fail to show the true results, since the azo benzene had exerted some control prior to the application of that spray. The rotenone combination applied to plot 53 was relatively effective. Velsicol 1068 in the last two sprays appeared to result in a lower infestation which may have been due to the reduction in DDT residues and activity of predators instead of its toxicity to the mites. A predatory mite became quite abundant on the unsprayed trees among these replants and also appeared in moderate numbers on the lead arsenate and the full-strength nicotine bentonite plots in series 1 and 2. It was present in small numbers on only a very few of the plots sprayed with DDT and then only where the least amounts had been used.

Special Tests with DDT-Miticide Combinations

Tests for mite control were started late in August with hexaethyl tetraphosphate and a few other insecticides in comparison with DN-111 in two local orchards sprayed with DDT. In one orchard, the Duchess trees used were moderately infested with the two-spotted spider mite and in the other, the Rome Beauty trees used had a moderate infestation of the European red mite which was on the increase. Most treatments, as given in Table 7, were tested on 2-tree plots in each orchard. The first application was made to Duchess on August 20 and to Rome Beauty on August 21. A second application was made to certain of the plots on September 3 and 4. The mite population on all plots was determined immediately before the first application and later on the dates and with the results shown in Table 7. On August 20 there were about one-third as many eggs of the two-spotted spider mite on Duchess as adults and nymphs the range in the various plots being from one-sixth to one-half as many. On Rome Beauty, however, the European red mite eggs were about three times as abundant as adults and nymphs and ranged from equal to five times as many. On August 27 the European red mite eggs on Rome Beauty outnumbered the mites 27 times on plot 4, and ranged down to 1-1/2 times as many on plot 1. This accounts in part for the rapid build-up of red mites on some of the Rome Beauty plots after the first application, and for a lack of build-up on the Duchess plots where there was a very low population of eggs. The tests were set up at a time of season when both species may have been getting ready for hibernation. At the time the tests were started some two-spotted spider mites were already appearing under the bark on the trees and in the calyx end of apples and red mites had already started laying eggs on twigs.

Table 7. Results of preliminary field tests with hexaethyl tetraphosphate in comparison with other miticides against separate infestation of the European red mite and two-spotted spider mites. Vincennes, Ind., 1946.

Plot	Materials (Quantities per 100 gal.)	Series 1/ D (Duchess) R (Rome B.)	No. Mites per 100 Leaves on Aug. 20-21	Percent Change in Population from that Present on Aug. 20. After 1st Spray		After 2nd Spray	
				8/27	9/3	9/5	9/10
1	No treatment	D	2,432	-30	-56	+8	-74
		R	1,325	- 5	+11	+66	+30
2	Deenate 1 lb.	D	2,845	-40	-77	-74	-77
		R	770	+ 3	+100	+27	+232
8	No. 2 + DN-111, 3/4 lb.	D	3,327	-97	-97	-98	-99
		R	1,028	-87	-49	-93	-98
9	No. 2 + DN-111, 1-1/4 lb.	D	2,672	-98	-100	-100	-100
		R	2,084	-98	-99	-100	-99
15	HETP (hexaethyl tetraphosphate) 2 oz.	D	1,062	-64	-99		
		R	1,182	-41	+64	(see 15A)	
15A	No. 2 + HETP 1-1/2 pt.	R				-95	-100
12D	Same as 15A (2 applications)	D	3,753	-97	-97	-100	-100
3	No. 2 + HETP 3/4 pt.	D	1,135	-93	-97	-99	-100
		R	1,298	-51	+37	-97	-98
5	HETP 6 oz.	D	1,656	-91	-92		
		R	2,325	-64	+16		
6	No. 2 + No. 5	D	3,714	-89	-95		
		R	1,109	-34	+20		
7	No. 5 + 8 oz. in 24 oz. Velsicol AR-50 + 1/2 oz. Triton B-1956	D	2,992	-89	-92		
		R	1,068	-88	+81		
4	NS 1/2 pt., MB 4 lb., dl 1 qt., Deenate 8 oz., HETP 8 oz.	D	2,285	-97	-99	-100	-100
		R	495	-95	+62	-99	-98
13D	LA 3 lb., Fermate 1 lb. Deenate 1/2 lb., HETP 3/4 pt.	D	2,419	-97	-99		
12R	HPF 50% emulsion 2 lb.	R	974	-40	-66		
13R	No. 12R + Deenate 1 lb.	R	1,296	-73	-45		
10	No. 2 + 1945 HPF 4 lb.	D	2,525	-86	-96		
		R	1,096	-92	+40		
11	No. 2 + 1946 HPF 4 lb.	D	2,925	-87	-87		
		R	1,064	-64	- 1		
14	No. 2 + BS 3 lb.	D	3,539	-64	-95		
		R	2,449	-51	-13		

1/ Ratio ERM to 2-SM on Duchess August 20 was 1:13; on Rome Beauty August 21 it was 99:1.

Although very promising, hexaethyl tetraphosphate did not appear to be much more effective than DN-111 as used at 1-1/4 pounds to 100 gallons and, in some cases, even at 3/4 pounds; however, it had the distinct advantage of not producing injury in any of the combinations used. Furthermore, it was almost immediately effective against mites, whereas DN-111 did not show its full effect for several days. Since the tests were conducted in the period when there was very little rainfall DN-111 may have been favored by this fact. Part of the reduction in population on Duchess plot 1 between August 20 and September 3 may be accounted for by the fact that a heavy population of Stethorus punctum was present on all plots at the time of the first application and remained abundant on plot 1. All plots sprayed with DDT, however, were almost entirely devoid of this predator a few days after the first application. The hexaethyl tetraphosphate used was of the technical grade with no added wetting agents. The formulations in which it was used, however, appeared to reduce the surface tension of the spray mixtures and where the larger quantities were used excessive run-off occurred.

It is significant that 8 ounces hexaethyl tetraphosphate in combination with DDT-nicotine bentonite and oil (Plot 4) gave exceedingly good results, especially after the second application. In another test started September 4 on mature Rome Beauty trees, hexaethyl tetraphosphate at 1-1/2 pints per 100 gallons with DDT proved no more effective than 1 pint and little more than 1/2 pint, indicating that the use of larger quantities may result in so much run-off that little added control of mites can be obtained. No significant differences were noted among the flavan compositions. Bentonite-sulfur at the rate of 3 pounds per 100 gallons with DDT gave fair results against the two-spotted spider mite but was less effective against the red mite.

Mites in Commercial Orchards

In 1946, a survey of the mite population was made on an average of four varieties in each of 26 orchards distributed over a 450 mile range from Elkhart, Ind., to Jackson, Tenn. Examinations were made at monthly intervals from June to September, inclusive. DDT was used in 20 of the orchards and was not used in 6. The European red mite was abundant from Vincennes north but a severe outbreak also occurred in one of the three Tennessee orchards examined. It was present in 19 of the sample orchards and absent from 7 located in an area extending from southwestern Indiana into southern Illinois and south across western Kentucky. The two-spotted spider mite was found in all orchards but was most abundant in an orchard near the Michigan line, in some of our plots at Vincennes, in an orchard at Omaha, Ill., and in orchards at Henderson and Paducah, Ky., and Greenfield and Jackson, Tenn.

The average number of mites per 100 leaves in groups of orchards receiving different programs is shown in Table 8.

Table 8. Average number mites on 2 to 5 varieties in 26 orchards distributed from Bristol, Ind., to Jackson, Tenn., 1946

Treatment	Number of Orchards	Species	Number of Mites per 100 Leaves June	July	August	September
No DDT used	6	ERM[1]	13	170	414	60
		2-SM[2]	0.3	74	30	28
DDT in 2 to 7 cover sprays	20	ERM	83	419	364	589
		2-SM	0.5	307	600	421
Dormant oil spray and 2 to 7 DDT cover sprays	10[3]	ERM	18	412	324	728
	13	2-SM	0.3	316	387	283
No dormant oil spray 2 to 7 DDT cover sprays	5[4]	ERM	264	822	920	999
	7	2-SM	0.9	286	587	582

1/ European red mite.

2/ Two-spotted spider mite.

3/ Not included are 2 orchards in western Kentucky and 1 in southern Illinois where no red mites were found.

4/ Not included are 2 orchard in western Kentucky where no red mites were found.

Both species of mites were most abundant in the orchards where DDT was used although the red-mite infestation became equal in August after several growers using DDT applied special miticide sprays. Several outbreaks in orchards sprayed with DDT early in the season were rapidly checked by predators later in the season after the DDT residues had diminished. In other instances where the grower was controlling mites by the addition of oil or DN-111 early termination of the spray program was almost invariably followed by a sharp rise in mite abundance three or four weeks later. Orchards where no DDT and very little sulfur were used in the first-brood cover sprays had practically no mite infestation.

Among the DDT sprayed orchards in which the European red mite was found those given a 3 percent oil spray in the dormant period had less than half as many red mites from June through August as those from which this spray was omitted. The dormant spray appeared to have no significant effect on the comparative abundance of the two-spotted mite. However, the thoroughness of application of dormant sprays in these various orchards varied considerably. Previous work has indicated that a thoroughly applied dormant application does exert some control effect on the two-spotted mite. Average orchard populations of the red mite

ranged up to 6,900 per 100 leaves as early as June and for the two-spotted mite up to 2,500 in July. On certain experimental plots at Vincennes the latter species attained population levels of 4,900 per 100 leaves in July and 14,600 in August. Equally high population levels were reached in 1945. Visible mite damage to foliage was evident in 17 of the orchards which received DDT and serious damage resulted on one or more varieties in at least 12 of them. Some serious damage from the red mite resulted in one orchard which received no DDT but where no cover sprays were applied as a result of a complete loss of crop from frost damage. This orchard had received the usual sulfur sprays. Another orchard which had a considerable red mite infestation and which received no DDT sprays was sprayed with sulfur or Fermate throughout the first-brood period, in combination with lead arsenate.

The predatory mite which has been in the genus *Seius* and *Seielus* but which, according to Dr. E. W. Baker, belongs elsewhere, was found in all six orchards which did not receive any DDT. Among the 20 orchards which were sprayed from 2 to 7 times with DDT, this predatory mite was found in only 3 and then not until three weeks or more after DDT had been used. The predator *Stethorus punctum* was present in all orchards where mites were found. It appeared to come in after mites began increasing and, in several instances, it brought mites under control rapidly after sprays of DDT were discontinued.

Dormant Treatments for the Reduction of Two-Spotted Mite Populations

Preliminary small-plot tests were set up in March, before any movement of the two-spotted mite from hibernating quarters had taken place, to test the value of dormant treatments against this species. The mites could be found readily under rough bark on the trees and in debris on the ground. Eight experimental treatments were applied to 16-tree plots divided into 4 replicates of 4 trees each. Two varieties, Rome Beauty and Starking, were present. All trees had been given a 3 percent dormant oil spray which, however, had no effect on many colonies of the two-spotted mite that were under bark where they were not reached by the oil.

In some plots the bark was removed from the trees by the use of a water spray at 600 pounds pressure, using about 65 gallons per tree. Treatments were applied to the ground, [redacted] and in one instance, after removal of the bark, the trunk was banded with tanglefoot (subsequently freshened at intervals) in an attempt to prevent any movement of the two-spotted mite up onto the tree. The results were not promising. Only about a 50 percent reduction in the two-spotted mite population was evident on plots that received 3/4 pound DDT dissolved in 2 quarts Velsicol AR-60 plus 2 gallons mineral oil and 6 ounces of B-1956 per 100 gallons at the rate of 675 gallons per acre. No reduction was evident where 3 gallons of the mineral oil per 100 gallons was used without the DDT. Likewise, no reduction was evident where 1/2 percent Elgetol supplemented with 1 ounce of Triton B-1956 per 100 gallons

was applied to the ground cover. Where the tangle-foot bands were used on trees from which the bark had been removed, the two-spotted mite population was more than 3 times as great as on the untreated check. The removal of the bark apparently increased the early build-up of the two-spotted mite possibly by causing the survivors to disperse and move out to the foliage earlier. Where the bark was not removed predators destroyed many of the colonies before they dispersed.

Bagworms

The bagworm rarely causes damage in apple orchards in southern Indiana, particularly where lead arsenate programs are used; however, during 1946, small outbreaks which partly defoliated the trees occurred in part of the Vincennes orchard where DDT has been used exclusively in all cover sprays applied since early in 1944. It is probable that the inclusion of some lead arsenate with DDT in the first-brood cover sprays will prevent future outbreaks.

Woolly Apple Aphid

A number of investigators in areas outside of the Middle West have reported that DDT sprays are followed by outbreaks of the woolly apple aphid, Eriosoma lanigerum (Hausm.). In the Vincennes area DDT, regardless of how used, appears to give almost complete control of this pest while numerous colonies occur on adjacent trees sprayed with lead arsenate. However, in orchards south of Vincennes in Kentucky and Tennessee, numerous outbreaks, generally of a minor nature, have been observed where DDT has been used. In these orchards, aphids parasitized by Aphelinus mali could not be found during, and for two or three weeks after, the period of application of DDT sprays. Later, after three or four weeks following the last DDT spray, this parasite was found to have almost completely annihilated aerial colonies of the woolly apple aphid in these orchards.

Grasshoppers

The red-legged and the differential grasshoppers have caused serious damage in local orchards. While these pests are able to defoliate trees that have been sprayed with DDT, there is no evidence to prove that the use of DDT has in any way been responsible for their presence in outbreak numbers.

Spray Residues from DDT

Analyses of DDT residues at harvest during the past three years have indicated that, under Indiana conditions, growers can apply 6 or 7 cover sprays of DDT at 3/4 pound actual DDT per 100 gallons to early fall varieties and avoid residues in excess of 7 parts per million if the last spray is applied not less than 30 days before harvest. Results indicate that DDT should not be applied to any variety after August 15 and between August 1 and 15 it should not be used in excess of about 4 ounces per 100 gallons in combinations containing oil nor in excess of 8 ounces per 100 gallons in other formulations. If oil is included in the spray mixture throughout the season the harvest residues from 7 sprays containing 1/2 pound actual DDT per 100 gallons may range up to more than twice the tentative tolerance. A combination program of nicotine bentonite plus oil with 4 to 6 ounces DDT per 100 gallons has generally left residue loads slightly below the tentative tolerance. The range of residue obtained from a number of the treatments tested in 1946 is given in Table 9.

Table 9. DDT Residues on Apples from Representative Spray Programs. Vincennes, Ind. 1946

Treatment	No. Sprays Applied	Variety	DDT per 100 Gallons	Date of Final Spraying	Date of Harvest	Residues
			pounds			PPM
DDT	6	Grimes	1/2	Aug. 1	Aug. 23	5.0 to 7.4
	7	Jonathan	3/4	Aug. 19	Sept. 9	7.9 to 10.6
	6	Turley	3/4	Aug. 9	Sept. 26	6.0 to 7.0
	7	Winesap	3/4	Aug. 19	Oct. 4	9.4 to 9.6
	6	Rome B.	3/4	Aug. 9	Aug. 28	3.6 to 5.9
DDT plus oil	6	Grimes	1/2	Aug. 1	Aug. 23	11.4
	7	Jonathan	1/4 to 1/2	Aug. 19	Sept. 9	11.5 to 12.0
	7	Winesap	1/4 to 1/2	Aug. 19	Oct. 4	7.5 to 13.1
	6	Rome B.	1/4 to 3/4	Aug. 9	Oct. 9	7.4 to 11.4
DDT plus nicotine bentonite and oil	6	Grimes	1/4	Aug. 1	Aug. 23	7.3 to 9.2
	7	Jonathan	1/4 to 3/8	Aug. 19	Sept. 9	4.4 to 9.3
	7	Winesap	1/4 to 3/8	Aug. 19	Oct. 4	7.9 to 8.2
	6	Turley	1/4	Aug. 9	Sept. 26	6.1
	6	Rome B.	1/4	Aug. 9	Aug. 28	3.2 to 6.3

Residue removal studies were conducted in 1946 to check on work previously conducted in 1944. We were again unable to consistently remove more than 25 percent of the DDT residue remaining at harvest. Rainfall in the Middle West tends to remove residues from the cheeks of the apples and to cause redeposition in the stem ends. There is no evidence that DDT degradation products are present in the DDT residues under local climatic conditions.

Distribution and Survival of Hibernating Larvae

Ten Winesap and two Ben Davis trees, all mature, were examined in detail along with three 20° sectors of the ground underneath from base of trunk to beyond the spread of the branches. The work was started in March and continued into the early part of the emergence period.

The average distribution of the surviving population in 1946, which totalled 856 larvae on the 12 trees, as compared to the average distribution for the grand total found on 105 trees examined previously follows:

	1946	1936 to 1946, Inclusive
No. trees examined	12	105
Average number live larvae per tree	71.3	65.7
Percent of total:		
On tree	89.8	80.4
Under bark	69.1	58.6
Within 10' of tree base	54.9	51.1
Beyond 10' from tree base	14.2	7.5
In cavities, crevices, breaks, stubs	19.5	21.8
Within 6' of tree base	4.4	5.3
Beyond 6' from tree base	15.2	16.4
On ground	10.2	19.6
Within 3' of trunk	2.1	8.9
3-6' from trunk	4.7	3.7
6-10' from trunk	2.5	5.1
Beyond 10'	0.9	1.9

Preferred quarters on the ground in order of their importance were bits of wood, weed stems, underbrush stubble, loose bark, and miscellaneous materials (including leaves, mummies, grass roots, straw and artificial materials).

BELTSVILLE, MARYLAND

E. H. Siegler, In Charge

Laboratory Experiments with Insecticides for Codling Moth

The number of tests of chemicals to determine their possible value as insecticides for newly hatched codling moth larvae was much less than usual because of the scarcity of rearing stock. Studies were made with the apple plug method using for each test about 100 plugs, each of which was infested with a single ready-to-hatch codling moth egg.

Organic Compounds

Synthetic.--As in past years synthetic organic compounds submitted by the Division of Insecticide Investigations, Bureau of Entomology and Plant Quarantine, were applied at the rate of 4 pounds per 100 gallons of carrier by means of a compressed-air sprayer. The results of these tests did not indicate anything of promise.

Among the synthetic proprietary organic compounds tested, benzene hexachloride (gamma isomer--12 percent), at a concentration of 4-100, was the most effective, but was less toxic than DDT at one-fourth that dosage. Compound H-3956 (Hercules Powder Company) in the form of a wettable powder (H-3956--25 percent) and as a miscible solution (H-3956--50 percent), each at the rate of 4-100 showed no promise.

Alkaloids.--A number of chemically pure alkaloids, namely nicotine, nornicotine, and anabasine, were prepared by C. V. Bowen of the Division of Insecticide Investigations for tests to determine whether combinations of any two alkaloids, at a total concentration equal to that of either one used alone, would result in an increase in effectiveness. The results indicated no advantage in combining these alkaloids. Even though less volatile than nicotine, nornicotine and anabasine were less effective than the former.

Inorganic Compounds

Silica gel.--Silica gel powder in very finely divided form was tested: (1) applied as a dust; (2) applied as a dust and then covered with water mist; and (3) as a suspension in water.

Silica gel powder when dry, in common with certain other dry powders, shows excellent effectiveness against newly hatched codling moth larvae. Silica gel, however, absorbs water readily. After it has absorbed water it is much less effective against codling moth larvae than when dry. When used as a suspension in water, at the rate of 8-100, it is also unpromising.

Hexaethyl Tetraphosphate

This spray material was originally developed in Germany where it was found effective against mites and aphids. At this laboratory it was first tried against codling moth larvae to determine its possible value as an insecticide.

The toxicity of hexaethyl tetraphosphate, at different concentrations, applied as freshly prepared solutions to apple plugs infested at once with ready-to-hatch codling moth eggs, is shown in comparison with that obtained for DDT and lead arsenate in the data given below:

Spray Material and Dosage		Percentage Wormy Apple Plugs
Hexaethyl tetraphosphate	1-100	0
Hexaethyl tetraphosphate	1/2-100	7
Hexaethyl tetraphosphate	1/4-100	50
DDT	1-100	4
Lead arsenate	4-100	47

Although effective shortly after application, hexaethyl tetraphosphate had lost nearly all of its toxicity by three days after application. It is said to hydrolyze to comparatively nontoxic compounds. It would therefore be of no practical value against the codling moth under orchard conditions.

Laboratory Investigations of Miticides

Studies of spray materials having for their objective the destruction of eggs of the European red mite, Paratetranychus pilosus C. and F., were discontinued when it was found that the mite eggs did not hatch satisfactorily under the conditions of our tests.

Bark scales infested with overwintering mites, believed to have been Tetranychus schoenei McG., were sprayed with a home-made lubricating oil emulsion diluted to contain 1, 2, 3 and 4 percent of oil. The mites were thoroughly wet and were killed by each of the concentrations used. The time required to kill was shortest with the 4 percent oil concentration and longest with the 1 percent. Under orchard conditions it would doubtless be difficult to obtain satisfactory kills of this mite with spray materials during the dormant period in view of the protected places in which they overwinter.

Two-spotted mite.--Further studies of potential miticides were conducted with the two-spotted mite, Tetranychus bimaculatus (Harvey), which was reared on beans grown in a greenhouse. For this work a leaf-disk technique was developed that proved very satisfactory for laboratory studies. Selected areas of bean leaves having a suitable number of mites were cut out with a cork borer 7/8" in diameter. The infested disks were then immersed in the test solutions for a period of three seconds. After dipping, the disks were placed in petri dishes and subsequently were examined with a binocular microscope to determine the mite mortality.

Comparative tests of DN-111, hydroxy penta methyl flavan, and azobenzene at different dosages were replicated three times. As shown by the results given below DN-111, containing as the toxic component 20 percent of the dicyclohexylamine salt of dinitro-o-cyclohexylphenol, was somewhat more effective than that of azobenzene. The latter was slightly more toxic than a water dispersible powder containing 25 percent hydroxy penta methyl flavan.

Material	Dosage (Pounds per 100 Gallons)	Percentage of Dead Mites
Check (distilled water)		9
DN-111	2	99
DN-111	1	89
DN-111	1/2	87
DN-111	1/4	50
Hydroxy penta methyl flavan	8	98
Hydroxy penta methyl flavan	4	92
Hydroxy penta methyl flavan	2	81
Hydroxy penta methyl flavan	1	63
Azobenzene C.P. 25%) impregnated on) clay, type "41," 75%)	16	99
DO.	8	99
DO.	4	100
DO.	2	93
DO.	1	76
Clay, type "41,"	4	11

Three replicated tests of DN-111, hydroxy penta methyl flavan, and lime-sulfur solution, the latter at several concentrations, were made. As shown by the data given below, lime-sulfur solution plus the chemically unreactive wetting agent Dreft was very effective as a miticide. Under field conditions, however, lime-sulfur is likely to burn foliage in certain fruit districts.

Material	Dosage (per 100 gal.)	Dreft (lb. per 100 gal.)	Percentage of Dead Mites
	Pounds		
DN-111	2	-	88
Hydroxy penta methyl flavan, 25% water dispersible powder	4	-	98
	Gallons		
Lime-sulfur	2	-	84
Lime-sulfur	2	1	98
Lime-sulfur	1 1/2	-	85
Lime-sulfur	1 1/2	1	100
Lime-sulfur	1	-	82
Lime-sulfur	1	1	100
Lime-sulfur	1/2	-	73
Lime-sulfur	1/2	1	99
Lime-sulfur	2	-	80
Lime-sulfur	2	1/2	100
Lime-sulfur	1 1/2	-	80
Lime-sulfur	1 1/2	1/2	99
Lime-sulfur	1	-	82
Lime-sulfur	1	1/2	99
Lime-sulfur	1/2	-	76
Lime-sulfur	1/2	1/2	98
Insecticide			
None (distilled water)	-	-	6
None	-	1	38
None	-	1/2	33

DN-111 and mixtures containing azobenzene, DDT, and combined formulations were replicated three times in a series of tests. All mixtures were made by mechanical methods. As shown by the tabulated data, azobenzene is highly toxic to mites and may have value under field conditions. The addition of DDT to azobenzene did not lower the miticidal value of the latter.

Insecticides 1/ 2/				
DN-111	Azobenzene, C.P.	DDT (technical)	Dreft 1/	Percent Mites Dead
1				82
1		3/4		98
1/2				80
1/2			1/2	100
1/2		3/4		100
	2			100
	2		1/2	100
	1			100
	1		1/2	100
	1/2			100
	1/2		1/2	100
	2	3/4		100
	2	3/4	1/2	100
	1	3/4		100
	1	3/4	1/2	94
	1/2	3/4		100
	1/2	3/4	1/2	100
		3/4		66
		3/4	1/2	69
Checks:				
Dreft			1/2	20
Clay "type 41", 2 1/				16
Distilled water				10

1/ All quantities, pounds per 100 gallons.

2/ Clay "type 41," 2 pounds per 100 gallons, used as diluent in all insecticidal formulations.

Type "41" clay, impregnated with azobenzene, C. P. in an acetone solution to give a powder containing 25 percent azobenzene and 75 percent clay was tested at 2, 4, and 8 pounds per 100 gallons alone and in combination with 3/4 pound technical DDT plus 1/2 pound Dreft. All concentrations of azobenzene alone and in all combinations gave 100 percent, or near 100 percent control.

A 25 percent DDT water-dispersible powder was tested alone and combined with Dreft at several dosages in comparison with one concentration of hydroxy penta methyl flavan and of azobenzene. Each test was replicated three times.

The results shown below indicate that high concentrations of DDT, 4-100, may give effective control of mites and that lower concentrations 1-100 may also be effective when combined with a wetting agent in proper proportions.

Insecticide 1/	Dreft 1/	Percent Mites Dead
DDT, 25% wettable powder:		
16		96
16	1	97
16	1/2	94
12		82
12	1	89
12	1/2	95
8		87
8	1	93
8	1/2	94
4		67
4	1	93
4	1/2	92
Hydroxy penta methyl flavan, 25% wettable powder:		
4		93
Azobenzene, 25% wettable powder:		
4		100
Check: Distilled water		5

1/ Quantities (pounds per 100 gallons).

Hexaethyl tetraphosphate as a Miticide

The leaf-disk technique, referred to on page 57, was also used in tests of hexaethyl tetraphosphate against the two-spotted mite, Tetranychus bimaculatus. This compound was tested alone at two strengths, 0.1 and 0.05 percent, and in combination with Dreft, 0.05 percent, at three strengths, 0.1, 0.05, and 0.025 percent. Applications were made with freshly prepared solutions, except in two tests in which the solutions were allowed to stand for one day before use. As shown by the following data, solutions of hexaethyl tetraphosphate freshly prepared and applied at concentrations of 0.05 percent and 0.1 percent, alone or combined with Dreft, were very effective against the nymphs and adults of this species as was 0.025 percent of the compound combined with Dreft. Solutions containing Dreft lost their effectiveness after aging for one day.

Material (Percentage by Weight in Water)	Age of Solutions Freshly Prepared	 1-Day Old
Hexaethyl tetraphosphate		
0.10	97	
.05	90	
.10)	100	32
.05) With Dreft, 0.05	98	40
.025)	97	
Dreft 0.05	34	
	12	
Check (distilled water)	0	
	4	
	3	

Hexaethyl tetraphosphate as an Aphidicide

Tests of hexaethyl tetraphosphate have been made at this laboratory to determine the effectiveness of this ester against plant lice. In view of the wide usage of DDT as an orchard spray, certain species of aphids may increase in abundance and cause considerable injury.

Most of the experiments have been conducted against the adult of the chrysanthemum aphid, Macrosiphoniella sanborni (Gill.), using hexaethyl tetraphosphate at the dosage of 0.025 percent plus the wetting agent, Dreft, 0.01 percent. Against several species of insects it has already been established that hexaethyl tetraphosphate loses toxicity on standing as a water solution. This is also true with respect to plant lice.

Studies here have shown considerable variation, some apparently inconsistent, in the toxicity of this material during the first 6 hours as a water solution. The contributing factors may be biological or they may be chemical. Enough data have been accumulated, however, to show that in general hexaethyl tetraphosphate solutions should preferably be used within about an hour or so after being made. The data also show, without exception thus far, that solutions which have aged 24 hours have lost practically all of their original effectiveness.

POUGHKEEPSIE, NEW YORK

D. W. Hamilton, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture, and J. L. Brann, Jr., New York Agricultural Experiment Station.

These investigations were carried on jointly by the Bureau of Entomology and Plant Quarantine and the New York State Agricultural Experiment Station at the Hudson Valley Fruit Investigations Laboratory, Poughkeepsie, N. Y.

Codling moth injury in 1946 in the Hudson River Valley was the lightest recorded since the establishment of this laboratory in April 1936. A number of factors contributed to this condition. The most important of these factors were light carry-over of worms from 1945, weather conditions so generally unfavorable for codling moth activity and development until about June 24 that early first brood injury was light and the number of moths developing to lay second brood eggs was small, and the use of DDT. While experimental data over a three year period has shown that DDT is the most effective insecticide available for control of codling moth, lead arsenate also gave good control in 1946.

Winter mortality of overwintering larvae was light, averaging 5 and 14 percent, respectively, in 2 orchards where counts were made.

The first pupae were found April 11, the first moths were taken in bait traps May 13, and the first larval entries in the fruit were found June 10. Peak captures of spring-brood moths in bait taps occurred May 30 to June 3, June 11 to 17, and June 24 to 26. While development started earlier than usual in the spring it was somewhat behind normal by the time for the first codling moth cover spray. First-brood moths began emerging in the insectary July 15 and bait trap captures began increasing in the orchards July 23. Peak captures of first brood moths occurred between July 29 and August 2; however, they averaged less than one moth per trap per day. The use of DDT in all orchards in which bait traps were maintained was partly responsible for the few moths caught in the bait traps. Heaviest first brood damage occurred between June 14 and 21 and heaviest second brood damage from August 9 to 16 and August 23 to 30. The number of hibernating larvae in most orchards is very small.

Field Tests of Insecticides

Spray Experiments - Moriello Bros. Orchard, New Paltz, N. Y.

Twenty-six single-tree plots replicated four times on medium sized McIntosh trees, were arranged in this orchard in which 30 percent of the fruit was injured by the codling moth in 1945. The grower applied a calyx spray of lead arsenate, 3 pounds, lime, 3 pounds, and sulfur, 8 pounds per 100 gallons, May 9, and a sulfur dust for scab protection May 17. The laboratory workers applied a spray similar to that used for the calyx application to all plots except No. 1 for scab and curculio control May 22 and again June 3. Plot 1 received only the sulfur. Cover sprays for codling moth control were applied June 12-14, June 25-26, July 5-6, July 16-17 and, to plot 25, August 14. Micronized sulfur, 6 pounds per 100 gallons was included with all treatments in the first cover spray. The infestation was so light and differences between most treatments appeared so small at harvest time that final results were taken in only five plots. The treatments of these plots and results were as follows:

Plot	Treatment (Pounds per 100 Gallons)	Number of Cover Sprays	Number of Apples per Tree	Number per 100 Apples Clean	Worms	Stings
1	None after calyx 1/	0	1095	--	12.6	6.8
18	Lead arsenate, 3, Lime, 3	4	1014	97.8	1.7	0.8
19	Benzene hexachloride (4.9% gamma), 3.5	4	1139	96.1	3.7	1.1
24	50% DDT (Deenate 50-W), 1.5	2	947	97.1	1.9	1.6
25	50% DDT (Deenate 50-W), 1.5	5	792	99.7	0.1	0.2

1/ Wormy fruit removed from 2 replicates at 7-day intervals.

Regardless of the treatment used, injury in this orchard by insects other than codling moth was inconsequential.

Large Scale DDT Spray Experiments Applied by Growers

Three large scale DDT spray experiments applied by growers were under observation in this area. Two of these tests have been maintained for two years. The principle variety in all orchards is McIntosh. The orchards used, insecticidal treatments applied for codling moth control and results are indicated in Table 1.

Table 1. Large Scale DDT Spray Experiments - Hudson River Valley - 1945-46
Variety - McIntosh

Block and Orchard	1945				1946			
	Apples per Tree	Apples Clean Percent	Number per 100 Apples Worms	Number per 100 Apples Stings	Apples per Tree	Apples Clean Percent	Number per 100 Apples Worms	Number per 100 Apples Stings
1. J. R. Clarke & Sons, Milton, N.Y. 1945 - 5 covers 25% DDT 4 lb/100 gallons 1946 - 4 covers 50% DDT 2 lb/100 gallons	2382	97.6	0.1	2.5	1528	99.6	0.1	0.4
2. E. S. Hubbard & Son, Poughkeepsie, N.Y. 1945 - 6 covers 25% DDT 4 lb/100 gallons 1946 - 3 covers 50% DDT 2 lb/100 gallons 1 cover 5% DDT dust	1943	95.3	1.2	4.7	5472	98.1	1.1	0.9
3. E. S. Hubbard & Son, Poughkeepsie, N.Y. 1945 - 6 covers LA-nicotine-phenothiazine-oil 1946 - 3 covers 50% DDT 2 lb/100 gallons 1 cover 5% DDT dust	1952	59.8	28.3	41.5	3045	93.1	5.6	2.4
4. J. R. Clarke & Sons, Milton, N.Y. 1946 - 3 covers 50% DDT 2 lb/100 gallons					1586	99.1	0.6	0.4

The record of catches of moths in the orchards in which the large scale DDT tests were conducted is indicative of the effectiveness of DDT and the general level of codling moth populations in this area. These records follow:

Orchard and Treatment	Year	Number of Moths Caught in 5 Traps				
		May	June	July	August	Total
Clarke - Block 1						
5 covers DDT	1945	1024	219	72	13	1328
4 covers DDT	1946	48	72	1	2	123
Hubbard - Block 2						
6 covers DDT	1945	1015	263	30	13	1321
3 covers DDT + 1 DDT dust	1946	127	85	1	13	236
Hubbard - Block 3						
6 covers LA-Nicotine-Phenothiazine	1945	264	285	43	25	617
3 covers DDT + 1 DDT dust	1946	50	75	20	26	171

Heavy populations of two-spotted spider mite, Tetranychus sp., built up in the Clarke orchard in September 1945. However, even with a heavy carry-over, the 1946 populations was very light until early in August when heavy populations again developed and were present on cover crops and apple foliage at harvest. Oil sprays were applied in the Clarke orchard during the dormant period of 1945 and 1946 for red mite control and this pest did not build up until early in August 1946 after which time it soon disappeared. Neither of these pests were of any importance in the Hubbard orchard in 1945 but in 1946 a moderate infestation of the European red mite was present late in July and the two-spotted spider mite bronzed the foliage extensively by harvest. Commercial injury, however, seemed negligible. Aerial colonies of woolly apple aphids were noticed in the Clarke and Hubbard orchards in July 1946. Observations made in nearby orchards sprayed with lead arsenate indicated that woolly apple aphids were more prevalent than in most seasons. Injury by other insects was minor in nature.

Dust Experiments

A series of ten plots was located in the Ed. Brown orchard near Red Hook, N. Y., on large sized McIntosh trees. Plots consisted of 3 to 6 trees each, replicated 3 times. Infestation records were taken from 2 trees in each plot. Applications prior to the first one for codling moth control were applied by the grower with a conventional type sprayer. A moderate scab infection occurred on leaves during the rainy period of May 4 and 5.

Seven dusts were applied for codling moth control with a Niagara direct drive duster. Between 2 and 3 pounds of dust were used per tree for each application. Five of these were applied during first brood worm activity on June 14, 22, 28 and July 5 and 13. The other 2 applications were made at the peak of second brood worm activity, August 12 and 19. Special applications of micronized sulfur dust to prevent secondary scab infection were made on all plots July 1, 21, and August 7. Plot 10 was sprayed with a conventional sprayer June 14, June 27, July 8, July 18, and August 17. There were only 5.34 inches of rain from the time of the first dust application on June 14 until harvest on September 2. Materials used and results obtained are shown in table 2. In the first codling moth cover 40 percent micronized sulfur replaced part of the talc listed in the formulations. While good commercial control was obtained with all dust treatments tested, treatment 8, in which veegum was included as a sticker for a 5 percent DDT dust, and treatment 7, in which lime was used as a safener for lead arsenate in a lead arsenate-DDT dust, were less effective than the others. Differences between the remaining treatments, all highly effective, were too small to permit drawing conclusions as to their comparative value.

Table 2. Infestation Records, Dust Experiment, Ed. Brown Orchard, Red Hook, N. Y., 1946.

Plot	Treatment	Apples per Tree	Percent Clean Apples	Number per 100 Apples: Worms	Number per 100 Apples: Stings
1	DDT 2.5%, Prorex D oil 2%, talc 95.5%	2971	96.3	2.5	1.9
2	DDT 5%, Prorex D oil 2%, talc 93%	2518	97.2	1.8	1.4
3	DDT 7.5%, Prorex D oil 2%, talc 90.5%	3016	99.0	0.4	0.7
4	DDT 5%, talc 95%	2341	96.2	2.7	2.0
5	Lead arsenate 20%, Prorex D oil 2%, talc 78%	2587	94.5	3.5	3.2
6	Lead arsenate 20%, DDT 2.5%, Prorex D oil 2%, talc 75.5%	2859	97.7	2.0	1.1
7	Lead arsenate 20%, DDT 2.5%, Prorex D oil 2%, lime 20%, talc 55.5%	3080	92.7	6.6	3.1
8	DDT 5%, dehydrated veegum 2%, talc 93%	3085	90.3	9.0	3.5
9	DDT 5%, blood albumin 12% (3% blood), talc 83%	2509	96.7	2.8	1.2
10	Conventional spray, 50% DDT 2 lb/100 gal., 5 covers	2738	99.5	0.2	0.4

Mist Spray Experiments:

Tests of a preliminary nature were made with a mist-sprayer by placing a 3 gallon per minute Bean Duplex Pump on a Niagara Direct Drive duster and inverting a small spray nozzle at the end of the 4 inch duster nozzle so that small amounts of spray were dispersed into the tree by the air blast. Application of approximately 1 pint per tree of a solution of 1 pound technical DDT in 1 quart xylene in kerosene diluted to make 1 gallon was toxic to foliage as was application of 1 quart per tree of the above mixture with mineral oil added, then diluted with 3 gallons of water and emulsified.

Present Status of DDT for Codling Moth Control:

The following conclusions have been made with respect to the use of DDT for codling moth control in this area as a result of 3 years experimental tests and its commercial use on at least 80 percent of the orchards in 1946.

1. DDT is the most effective insecticide available for controlling the codling moth.

2. A 50 percent wettable powder is the most practical type of formulation. Formulations of DDT in various solvents have left residues of DDT on harvested fruit above 7 ppm. In most orchards commercial codling moth control can be obtained by applying 3 to 4 cover sprays at intervals of 10 to 14 days during first brood larval activity, using 2 pounds of a 50 percent wettable powder to 100 gallons.

3. DDT dusts are less effective than sprays in controlling the codling moth but will give commercial control if applied often enough. Generally, 7 to 8 dust applications will be needed to replace 4 to 5 spray applications. Residues of DDT on harvested fruit are lower when DDT is applied as a dust than when it is applied in sprays. Dusts are of special value when it is desirable to treat a large area in a short time and for use to control the second brood when protection is needed during that period.

4. DDT is compatible with the wettable and paste sulfurs commonly used as fungicides in this area. It is incompatible with summer oil and should not be used with it; neither should oil be applied immediately following DDT sprays.

5. In the short time that DDT has been used for codling moth control in the Hudson Valley fruit insect pests other than the codling moth have not yet caused serious injury. However, the presence of two-spotted spider mites in orchards in this area is attributed to the use of DDT since it is now readily found in orchards where DDT was applied, whereas previously it had not been reported as a pest on apples in this area.

DDT Residues on Harvested Fruit:

DDT residue analyses were made by the Division of Insecticide Investigations, Beltsville, Md., from 18 of the replicated spray plots, the large scale grower sprayed plots and 5 of the experimental plots. Samples were taken at the time of harvest by walking around the sample trees and picking apples at random. Fifteen apples were taken from each tree and each sample was replicated three times. All samples taken were from McIntosh trees. Two of the samples from the plot which received no DDT sprays had comparatively large quantities of chlorine on them when analyzed while samples from the third replicate had no chlorine present. Small quantities of DDT could have been deposited on these trees by spray drift from plots adjacent to them but the third replicate was as close to DDT sprayed trees as the other two.

The analyses showed wide variations in the amount of DDT residue between replicates of the same treatment. The variation in harvest residues was greater between samples from sprayed plots than between those from dusted plots. As in 1944 and 1945, harvest residues were greater on sprayed fruit than on dusted fruit. Harvest residues of DDT exceeded 7 ppm. when DDT was used in 5 cover sprays at 1 pound per 100 gallons when the last cover spray was applied August 17 and the fruit was harvested September 2 and were near 7 ppm. when DDT was used in a similar program at 3/4 pound per 100 gallons. In the first case 2 of the 3 samples exceeded 7 ppm. and in the latter case only 1 of the 3 exceeded that amount.

Analyses made in previous seasons had indicated that 5 sprays of DDT at 1 pound to 100 gallons would leave harvest residues within the tentative tolerance. Several factors were probably responsible for the increase in the residues of DDT present on harvested fruit this season. Among such factors may have been the availability and use of improved formulations of DDT in 1946, a deficiency in rainfall, and the smaller size of the fruit in 1946 as compared to 1945. Four covers of DDT applied at the time first brood worms were entering the fruit left residues within the tentative tolerance except in one instance in which the sample from one replicate exceeded the tolerance. In the dust experiments residues of DDT at harvest were well within the tentative tolerance when as many as 7 applications of a dust containing 7.5 percent DDT were applied.

A summary of the residue analyses are presented in Tables 3, 4, and 5. Results are corrected for the reagent blank only.

Table 3. Harvest Residues of DDT on Fruit from Experimental Spray Plots
Moriello Bros. Orchard, New Paltz, N. Y., 1946 1/
Variety - McIntosh

Analyses by Division of Insecticide Investigations, Beltsville, Md.

Plot	Treatment (Amounts per 100 Gallons)	DDT/PPM Replicate A	B	C	Average all Replicates
1	No insecticide after calyx	2.0	1.2	0.0	1.1
2	Deenate 25-W, 4 lb., 4 covers	2.2	4.0	3.3	3.2
3	Deenate 50-W, 2 lb., 4 covers	5.6	3.2	4.0	4.3
4	Deenate 50-W, 1.5 lb., 4 covers	3.3	3.1	4.0	3.5
5	Deenate 50-W, 1 lb., 4 covers	2.3	0.0	5.3	2.5
6	Deenate 50-W, 1.5 lb., 1st & 2nd covers Deenate 50-W, 1.5 lb., + QTH oil + 2% B-1956, 3rd & 4th covers	2.7	0.1	5.8	2.9
7	Deenate 50-W, 2 lb., 3 covers	2.3	5.0	2.6	3.3
8	Unico (50% DDT) 2 lb., 4 covers	5.4	8.4	3.9	5.9
9	Geigy AK 50 DDT, 2 lb., 4 covers	0.1	1.9	4.1	2.0
11	Deenate 75-W, 1 lb., 4 covers	3.6	3.6	3.9	3.7
12	Deenate 25-R, 1 qt., 4 covers	3.7	4.7	3.2	3.9
13	Syndeet (30% DDT), 1 qt., 4 covers		6.3	5.6	6.0
14	Deenate 50-W, 1.5 lb., 1st & 2nd covers Genicide A (27.5% DDT), 2 lb., 3rd & 4th covers	0.8	1.4	2.3	1.5
15	DDT Concentrate (25% DDT), 3 lb., 4 covers (Mfg. by Tobacco-By-Products)		3.4	2.0	2.7
17	Black Leaf 155Y (7% DDT), 3 lb., 4 covers	2.1	4.4	0.0	2.2
23	DDT Pyrophyllite (50% DDT), 2 lb., 4 covers	2.1	2.5	2.8	2.5
24	Deenate 50-W, 1.5 lb., 2 covers	3.3	2.4	1.0	2.2
25	Deenate 50-W, 1.5 lb., 5 covers	4.8	10.6	6.1	7.3

1/ Fruit harvested September 5, 1946.

Table 4. Harvest Residues of DDT on Fruit from Large Scale Grower Experimental Spray Blocks, 1946. 1/ Variety--McIntosh.

Analyses by Division of Insecticide Investigations, Beltsville, Md.

Plot	Orchard	Treatment (Amount per 100 Gallons)	DDT/PPM Replicate A	B	C	Average all Replicates
1	J.R. Clarke & Sons Milton, N.Y.	DDT 50%, 2 lb. in 4 covers during 1st brood (Dupont's Deenate 50-W)	4.4	3.8	3.4	3.9
2-3	E.S.Hubbard Poughkeepsie, N. Y.	DDT 50%, 2 lb. in 3 covers during 1st brood + 50% DDT dust in 1 cover during 2nd brood (Sherwin-Williams 50% DDT)		3.7	2.9	3.3
4	J.R. Clarke & Sons Milton, N.Y.	DDT 50%, 2 lb. in 3 covers during 1st brood (Niagara 50% DDT)	1.3	3.9	4.4	3.2

1/ Fruit harvested September 4, 1946.

Table 5. Harvest Residues of DDT on Fruit from Experimental Dust Plots, E. Brown Orchard, Red Hook, N.Y., 1946. 1/ Variety--McIntosh.

Analyses by Division of Insecticide Investigations, Beltsville, Md.

Plot	Treatment		DDT/PPM Replicate A	B	C	Average all Replicates
1	DDT 2.5%, Prorex D oil 2%, talc 95.5%	7 covers	0.9	3.0	1.6	1.8
2	DDT 5%, Prorex D oil 2%, talc 93%	7 covers	1.7	1.9	2.7	2.1
3	DDT 7.5%, Prorex D oil 2%, talc 90.5%	7 covers	2.5	2.9	3.9	3.1
4	DDT 5%, talc 95%	7 covers	1.7	1.2	2.5	1.8
10	DDT 50%, 2 lb/100 gallons Conventional spray	5 covers	8.4	12.7	7.0	9.4

1/ Fruit harvested September 2, 1946.

Orchard Mites - Poughkeepsie, New York, 1946.

R. W. Dean, New York Agricultural Experiment Station.

Eight schedules of cover sprays were compared to determine their effects on European red mite populations. In addition, half of each plot received a delayed dormant application of 3 percent oil. The schedules are shown in Table 1.

Mite populations were sampled at one or two-week intervals from June 13 to November 14. With few exceptions, the half of each block which was sprayed with oil at the delayed dormant stage developed less of an infestation than the unoiled half. The greatest populations occurred on the unoiled trees in Plot 10, the next greatest in Plot 9. Plot 3 populations were slightly lower than those in Plot 9 and Plot 7 populations less than those in Plot 3. Plots 4 and 5 showed a fair degree of control although there was some build-up after spraying stopped. Plots 6 and 8 developed the least mite infestation, the former being the lighter of the two.

Serious spray burn occurred in Plot 8 due to the combination of DN-111 with sulfur used at high temperatures. Slight burning was also observed in Plots 5 and 6.

There was again no evidence that increased numbers of the European red mite resulted from the use of DDT. Mite infestations were common in DDT-sprayed orchards but were also found in orchards which had received the usual lead arsenate-nicotine-oil schedule. Infestations of red spider mite, on the other hand, were limited to DDT-sprayed orchards. This pest was abundant and widespread in 1946. A series of dormant and semidormant treatments with oils and dinitro materials were applied. No effect on the spider mite could be observed as natural mortality in the spring eliminated mites which overwintered on the trees. Subsequent heavy infestations developed from individuals overwintering on the ground. A limited test of summer treatments for spider mite control showed DN-111 and hexaethyl tetraphosphate to be effective.

Table 1. Spray Schedules for European Red Mite Tests - 1946

Plot No.	1st Cover 6/14	2nd Cover 6/25-26	3rd Cover 7/5	4th Cover 7/16	5th Cover 8/12	6th. Cover 8/22
3	DDT 2#, LA 3# Lime 3#, WS 5#	DDT 2# WS 6#	DDT 2#	DDT 2#	DDT 2#	DDT 2#
4	DDT 2#, LA 3# Lime 3#, WS 5#	DDT 2# WS 6#	Genicide A 2#	Genicide A 2#	Genicide A 2#	Genicide A 2#
5	DDT 2#, LA 3# Lime 3#, WS 5#	DDT 2# Flavan 5# WS 6#	DDT-flavan 5#	DDT-flavan 5#	DDT-flavan 5#	DDT-flavan 5#
6	DDT 2#, LA 3# Lime 3#, WS 5#	DDT 2# WS 6#	Dow C-622 1 qt.	Dow C-622 1 qt.	Dow C-622 1 qt.	Dow C-622 1 qt.
7	Syndeet 1 qt. LA 3#, WS 5#	Syndeet 1 qt. WS 6#	Syndeet 1 qt.	Syndeet 1 qt.	Syndeet 1 qt.	Syndeet 1 qt.
8	DDT 2#, LA 3# Lime 3#, WS 5#	DDT 2# WS 6#	DDT 2# Dow C-456 1-1/4#	DDT 2# Dow C-456 1-1/4#	DDT 2# Dow C-456 1-1/4#	DDT 2#
9	LA 3#, lime 3# Nic. sulf. 1 pt.	LA 3#, nic.sulf. 1 pt. Fermate 1-1/2#	BL155 3#	LA 3#, lime 3#	BL155 1-1/2# Oil 2 qt. B 1956 1 oz.	BL155 1-1/2# Oil 2 qt. B 1956 1 oz.
10	LA 3#, lime 3# WS 5#	LA 3#, lime 3# WS 6#				

DDT=50% wettable spray powder. LA=lead arsenate. Lime=Hydrated spray lime. WS= wettable sulfur paste. Nic.sulf=Nicotine sulfate (40% nicotine). Syndeet=Naugatuck Chemical Co. product containing 30% DDT in solution in an emulsible base. Flavan=Hydroxpentamethyl flavan. DDT-flavan=16.6% DDT and 20% hydroxy pentamethyl flavan. Genicide A=General Chemical Co. product containing 37.5% DDT and 45.5% xanthone. Dow C-622= 12-1/2% DDT in solution in an emulsible base. Dow C-456= DN-111 with reduced amount of wetter. BL155=Black Leaf 155 (14% nicotine). Oil=Summer spray oil (raw). B 1956=Triton B 1956 Emulsifier.

Apple Maggot Investigations - Poughkeepsie, New York - 1946

R. W. Dean, New York Agricultural Experiment Station in Cooperation with the U. S. Bureau of Entomology and Plant Quarantine.

A commercial wettable spray powder containing 50 percent DDT, when used at the rate of 2 pounds per 100 gallons in the second, third and fourth cover sprays, reduced apple maggot infestation in the fruit from 32.15 percent in 1945 to 0.84 percent in 1946 in a fairly well isolated block of trees which was not subject to fly migration. In a similar test, employing a different brand of wettable spray powder, fruit infestation was reduced from 95 percent to 36.3 percent. There was also a considerable reduction in number of punctures per fruit. The difference in results is not attributed to the different brands of spray material but to the orchard surroundings. In the second case, the planting adjoined a woods on three sides. The woodland margins were unsprayed. Four applications of the same DDT formulation were made to a similarly situated orchard on the same farm, the first three being the second, third and fourth cover sprays and the last one intermediate between the fourth and fifth covers. Fruit infestation was reduced from 95 percent to 12.53 percent with, again, a reduction in numbers of egg-punctures per fruit. It is apparent that, in orchards adjoining woods, hedgerows or unsprayed apple trees, the margins of these must be treated when using DDT, just as is recommended with the lead arsenate schedule, or spraying must be continued for as long as fly migration is heavy. Apparently, DDT applications, at the concentrations used, remain effective for about ten to fourteen days. The three applications in the second to fourth cover sprays are sufficient to give protection during the period of fly emergence but not over the entire period of fly activity.

Five percent DDT dust, applied ten days after the beginning of fly emergence and three times thereafter at 8-day intervals, reduced maggot infestation from 40 percent to 2.86 percent. Where a fifth application was made, the reduction in injury was from 25 percent to 0.62 percent.